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THE

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A MODERN SAUL OF TARSUS.

"And there fell from his eyes as it had been scales: and he received sight forthwith."

Whilst the agencies by means of which a man's conversion may be brought about are very diverse, there is no more hopeful sign in the sceptic than *the wish to believe*. This state of mind is an almost certain prelude to a sound and lasting conversion to the truth, and there is no surer sign of the soundness of the change than that the convert should immediately preach to all the world his newly acquired gospel.

It is matter for congratulation and rejoicing, therefore, that "Mabon," the worthy Labour M.P. and spokesman for the Welsh miners, has returned from his visit to the States thoroughly cured of the prejudice which he, with others, had entertained against all labour-saving machinery: and, better still, he is now to be reckoned among its most ardent champions, prepared to co-operate with capitalists in promoting reforms, and in convincing the working man that the opposition to machinery is based on a pernicious doctrine and a most disastrous fallacy.

A visit to the States is a wonderful eye-opener in many ways, and the money of those employers who have sent workmen to study American labour methods, will be well spent if the men return as fully convinced as Mr. William Abraham, M.P., of the utter and criminal imbecility of the "Newer Unionism," as we know it in England.

Through the false doctrines hitherto taught by their trusted labour leaders, it has become almost an article of faith of the average trades unionist that labour-saving machinery is his worst enemy, to be fought tooth and nail, and against which he must defend his trade as he would shield his dearest child from a loathsome pestilence.

Obviously, labour-saving machinery implies increased production with no direct increase in labour; or, as the worker prefers to regard it, the same output with a reduction in labour. "If that machine will turn out as much work as two men, one of us will get the sack," is a not unnatural remark on the part of a workman imbued with the old-fashioned doctrine of supply and demand.

It is as yet only dimly appreciated that this doctrine is out of date, and the revised version should read that trade and demand are conditional upon supply and cheapness of production; and that the effect of machinery, by multiplying the consuming power of the individual and the community, is to increase the demand for labour as it does the demand for goods.

Practical illustrations are far more convincing to the worker than are theories of supply and demand, into which so much sophism can be, and is, interwoven. The manager of a small engineering works, which we had occasion to visit recently, is somewhat of an enthusiast in the matter of labour-saving tools. A little while ago he was explaining to his

leading hands an idea he had for reducing by 30 per cent. the time spent on a certain production. "Oh no!" they said, "you have gradually got the time down, till now it is at its absolute minimum, and it is quite impossible to do any better." Their idea—being trades unionists and piece workers—was that, if the labour could be reduced by 30 per cent., the number of hands, or the piece rate, might also be reduced in the same proportion. The manager was prepared for this argument, and turning to the oldest hand, said:—"You can remember that a few years ago, when we first began making these machines, the time put on each was four days; now it is three hours, and we turn out normally 120 a week. How many, think you, should we turn out if we still put four days' time on each? Why, none at all, for you know, as well as I do, that we should have to close the works and pay you all off." And although this is rank heresy, judged by the gospel of the newer unionism, the men knew it to be the truth.

"Mabon" is particularly interested in coal mining, and he, doubtless, saw in the States the most up-to-date applications of machinery to this class of work, and obtained figures as to the proved economy in production. The substitution of electrically-driven pumping plant for pumps driven by miles of wire rope, or by steam transmitted through hundreds of yards of piping; the application of electric motors to hauling, winding, coal cutting, drilling, and the like, are matters which demand the serious attention of every enterprising colliery manager.

We need not go so far as America in order to learn something of the economies that have been effected by a judicious use of such machinery. In one instance in the North of England, an electric pumping installation, costing £3,600, paid for itself in three years, that is to say, after allowing for interest and depreciation on the outlay, the costs of working were £1,200 per annum less than by the old method of wire-rope driving. In one of the North Wales Collieries, after trying electric haulage on a portion of the roads, the owners were so satisfied as to the economy, that they spent upwards of £14,000 on electric haulage alone.

Owing to the refusal of the miners in a Yorkshire colliery to agree to a reasonable "getting" price, electric coal-cutting machines were introduced, resulting in an output of 6 tons per machine per day, as against 3¼ tons per man per day. The cost of 2s. 1½d. per ton by hand was reduced to 1s. 3½d. by machine, a saving of 10d. a ton. As the output is about 800 tons a day, the annual extra output and saving in cost is easily calculated. In another colliery the cost of 2s. 3d. per ton by hand was reduced to 1s. 4½d. per ton by machine.

The machine-got coal is more cubical in shape, has a better appearance, and commands a higher price, while there is a lower percentage of small than in coal got by hand. In the report on an installation of 16 machines, we read, "the coal-cutting portion of the outfit is paying at least 50 per cent. on the original investment."

But the urgent necessity for the adoption of adequate machinery to enable Great Britain to compete with other countries in the industrial struggle, and to hold her own in the markets of the world, is but one of the principles to which our worthy labour champion has become a convert. Another, and equally important one, is that of "non-interference." It is useless to have machinery if its output is to be restricted by the meddlesome interference of trade unionist demagogues.

The interference practised by British trade unionism is of two kinds, and has been the direct cause of the most disastrous and costly battles on record between employer and employed. One kind is the interference with a man who is *not* in the ranks of unionism, and the other with the man who is.

In the former case it is sought to prevent him working at all, and in the latter to control his output. In other words, the unionists want to secure both the monopoly of labour and the works management.

So far as the engineering trades are concerned, it is to be hoped that the last strike settled these questions once and for all. The terms embodied in the sort of "Treaty of Peace" drawn up at the conclusion of the struggle have now had a trial of four years. These terms gave the masters the right to employ practically any man they chose, and to determine the conditions under which any machine tool should be worked.

Although the "conditions" have been accepted and signed by the executive officials of the Masters' Federation and the Allied Trades Unions, they have been practically rejected by the men. The result of a ballot shows 9,714 votes for, and 16,563 against, the agreement. As, however, the total number of votes recorded is only one-fourth the number of members, it is quite possible that the remaining apathetic three-fourths are not opposed to the terms.

So many instances of the tyrannical interference on the part of the A.S.E. members with non-union men have been already given, that it may be a case of supererogation to cite another. Here, however, is an unusual one. An engineer, a first-rate man at his work, moved from one town to another. Having got a "start" in an engineering works, he was soon accosted by a "delegate," who wanted to see his ticket. "I am not in the Union," he said. "Then you can't work here." "But your Union refuse to accept me, because I wear glasses"! After much correspondence with headquarters, and a certificate from his last employers that his defective sight had not been detrimental to his work during the years he had been in their employ, this engineer was *permitted* to work on condition that he behaved in all respects as a unionist, and complied with union rules, although not permitted to become a member. That is, he had to put up with all the disadvantages, including strikes, of unionism, and participate in none of the advantages.

As to the opposition to labour-saving tools and the restriction of output, volumes might be written. We know of a fitter who was reprimanded because he made a special chisel to do some chipping. He performed by this means in half a day what was reckoned by his unionist mates a two days' job.

The present glass-workers' strike is the result of trades unionist interference in the management. There is no dispute as to wages or hours, the men having received a bonus, to which they were scarcely entitled, on the very morning on which they struck work.

If the conversion of "Mabon" has the effect of loosing the scales from the eyes of a few other labour leaders, those blind leaders of the blind who have already wrought such mischief to the trade of the country, and such misery in the homes of the workers; and if others, by his example, find how useless it is for them to kick against the pricks, his visit to America will have far-reaching results, beneficial alike to employer and employed.

THE PHASE DISPLACEMENT OF ALTERNATORS AND PARALLEL RUNNING.

By H. C. LEAKE, A.M.I.C.E.

(*Concluded from page* 544.)

If now the applied torque fluctuates periodically, the angular velocity of the alternator will also fluctuate with the same periodic time, and consequently it is necessary to allow for the positive and negative torque required for accelerating the fly-wheel and other rotating parts. In order to take this into account in a simple manner in the diagram, we will assume that the law of the fluctuation of the applied torque is such that ϕ fluctuates with regard to time according to a sine law, the mean value of ϕ being O P corresponding to the torque O T. If there are p pairs of poles, it follows that $\left(\frac{\phi - \text{O P}}{p}\right)$ is at every moment the angle by which the rotating portions of the alternator are in advance of the position they would occupy if the rotation were uniform, which angle is called the instantaneous phase displacement as explained at the beginning of this article. It will, therefore, be seen that the abscissæ in the diagram also represent phase displacement to a different scale.

Thus the angular acceleration of the rotating parts is $\frac{1}{p}\frac{d^2\phi}{dt^2}$, and if, in accordance with the above assumption, ϕ is represented by $(\text{O P} + a \sin 2\pi n t)$, where n is the frequency of the fluctuation of the applied torque, then the angular acceleration becomes

$$-\frac{4\pi^2 n^2 a}{p} \sin 2\pi n t = -\frac{4\pi^2 n^2}{p}(\phi - \text{O P}).$$

Consequently the torque, which has to be exerted by the prime mover in the direction of rotation in order to accelerate the fly-wheel, &c., is given by $-\frac{4\pi^2 n^2 \text{I}}{p}(\phi - \text{O P})$, where I is the total moment of inertia. This inertia torque can be easily calculated, and is represented on the diagram by the straight line, G H, drawn through the point P. It should be noted that the slope of this line is independent of the amplitude of the oscillation. For the purpose of this illustration, it has been assumed that the stored energy of the rotating parts is 3,500 foot-tons at 93·8 revolutions per minute, and that the periodic time of the fluctuation of torque is equal to the periodic time of the revolution.

By adding the ordinates of the curves E F and G H we get the curve K L, which gives for every point in the oscillation the resultant torque which must be applied by the prime mover.

If now the applied torque fluctuates between O T_1 and O T_2, the law of the fluctuation of torque being such that the fluctuation of ϕ follows a sine law, then ϕ must fluctuate between O P_1 and O P_2, the periodic time of the fluctuation of ϕ being, of course, the same as that of the applied torque. The corresponding values of the components of the fluctuating current are given by the intersection of ordinates at P_1 and P_2 with the curves A B and C D. It will be convenient if we give a special name to the amount of periodic fluctuation in the electrical output of a set at a given mean load under the conditions assumed, so we shall term this "the characteristic fluctuation of output."

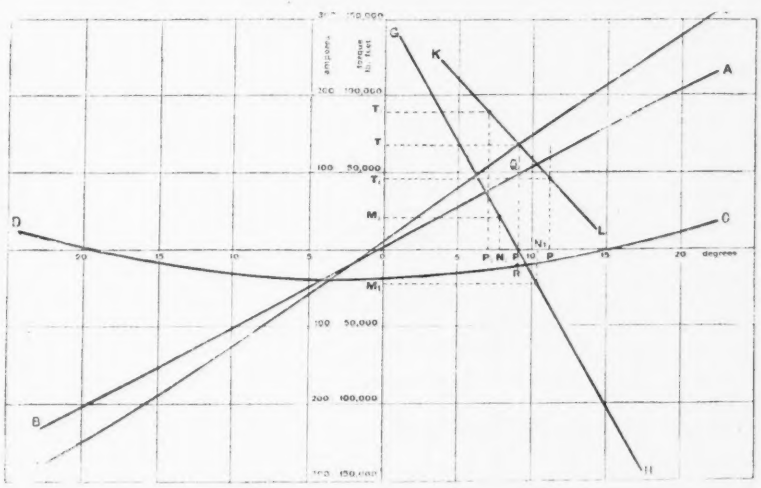
If, instead of being in parallel with others, the set is running alone on a load offering a constant torque, as is practically the case when it is running on a water resistance, then the same fluctuation of driving torque causes ϕ to fluctuate between O N_1 and O N_2 where O M_1 = O M_2 = $\frac{1}{2}$ (T_1T_2). P N_1 or P N_2 is what is commonly known as the maximum phase displacement of the set at this load, giving it the limited meaning as explained at the beginning of this article.

It is evident from the diagram that, when the slope of the resultant torque curve, K L, is less (in either direction) than the slope of the inertia line, G H, the actual maximum phase displacement of the set when running in parallel is greater than when running on a load offering a constant torque. Since the slope of these curves depends on the moment of inertia selected, it follows that if the moment of inertia of the rotating portions of a generating set *exceeds* a certain amount, the actual maximum phase displacement when running in parallel exceeds that when on a load offering a constant torque. Moreover, if we consider the effect of varying the moment of inertia, we see that, as the resultant torque curve, K L, approaches the horizontal, the fluctuation of ϕ, and consequently of angular velocity and of current, also become very large. For every set there is thus a critical value of the moment of inertia, depending on the periodic time of the fluctuation of driving torque, such that the characteristic fluctuation of output becomes very large, and such that the conditions can be improved either by reducing or by increasing the moment of inertia.

In view of the above conclusions, the author maintains that the usual method of proportioning the moment of inertia of the rotating parts of generating sets does not rest on a correct theoretical basis, and that the action of a set when on a load offering a constant torque cannot be a correct guide to its action when in parallel with others.

A few remarks may now be passed on the assumptions which have been made. It has been assumed that the curves A B, C D, and E F, hold at every instant during the oscillation, but this is not strictly correct, since these curves relate to one particular speed. Hence the calculation must be considered as correct only when the oscillations are small, and the diagram will be departed from when they become large.

It has been assumed that the curve of driving torque (which should be corrected for inertia of reciprocating parts) is of a shape which fulfils a certain condition. As the curve K L is practically a straight line within the limits of the diagram, it follows that this condition requires that the fluctuation of driving torque shall follow a sine law with regard to time. When the torque curve is irregular, as in actual cases, it can be split up into a number of sine components, and the effect on the oscillations, due to each component separately, can be considered. In some cases one component may be of most importance, and in other cases another. This suggests that it might possibly be advantageous sometimes to design or adjust prime movers merely with a view to keeping one particular component of the torque as small as possible without paying much attention to the others.



With single-phase alternators there is, as is well known, a fluctuation in the power output at a rate equal to twice the frequency. As far as this particular fluctuation is concerned,

the ordinates of the curve, E F, should represent mean applied torque, as the rate of this fluctuation will usually be too rapid to effect this investigation.

The best method of studying the oscillations of synchronous machinery is by means of the natural period of oscillation. When used in reference to a single machine, this is the periodic time of the natural oscillations of the rotating parts of a machine, whether generator or motor, if the applied torque, either driving or resisting, were uniform, and if the machine were running on bus bars, the P.D. between which is independently maintained absolutely constant in effective value and periodicity. It depends on the magnetic and electric characteristics of the machine, and on the moment of inertia of the rotating parts. It can be shown that under the above conditions the amplitude of the oscillation produced by a given periodic fluctuation in the torque applied to the machine, depends on the closeness of equality between the natural period and the period of fluctuation of the torque, and that when the conditions are such that the curve K L becomes horizontal, and the fluctuations of phase displacement and current are very large, the natural period is (neglecting damping) equal to the period of fluctuation of the torque—the action being in fact of the nature of a resonance effect.

In conclusion, we may consider the bearing of this investigation on actual practice. When two or more alternators are run in parallel on a given constant load, the object which it is desired to attain is that the P.D. between the bus bars shall remain perfectly constant, both in effective value and in periodicity. If the effective value fluctuates, then a fluctuation is produced in the brilliancy of lamps fed with the alternating current. If the periodicity fluctuates, then there is a fluctuation produced in the speed and current of synchronous motors and rotary converters running on the system. Such fluctuations are always present to some extent, and whether they are objectionable or not in practice is entirely a matter of degree.

Assuming for the moment that the ideal constancy in the P.D. has been secured, diagrams of the kind which has been described show for every generating set what fluctuation in output will be produced by the given fluctuation in its turning moment; this fluctuation in output being what we have termed "the characteristic fluctuation of output." As the outputs of all the alternators will be simultaneously fluctuating in amount in accordance with the principles which have been explained, it follows that, in order that our assumption as to constancy of the P.D. shall hold, the fluctuations, both of phasal and wattless current, must cancel one another, so that the sum of the outputs of the several sets can be always equal to the constant load on the bus bars. Now this condition is very unlikely to be fulfilled, though, strictly, not always impossible, and hence we may conclude that the effective value and periodicity of the P.D. will not remain constant, but must periodically fluctuate to some extent. Such fluctuation in the P.D. will modify the fluctuations in the outputs of the several alternators, and matters will adjust themselves so that the sum of the actual fluctuating outputs is equal to the load on the bus bars. The actual fluctuation of output of any set is then, of course, different from its characteristic fluctuation of output.

Although it is impossible to calculate the actual periodic fluctuation in the effective value and periodicity of the P.D. when two or more sets are run in parallel, yet it seems reasonable to assume that, as a general rule, the smaller the characteristic fluctuations of output of the several sets, the less will be the periodic fluctuation of bus bar P.D. when running in parallel, provided, of course, that there is at least sufficient fly-wheel power to meet the requirements of non-periodic changes of load, &c. The author would, therefore, suggest that, instead of designing the rotating parts of generating sets so that the maximum phase displacement does not exceed a given limit under conditions differing essentially from those under which they are operated, as appears to be customary at the present time, they should be so proportioned that the characteristic fluctuation of output does not exceed a given limit. It is not contended that this latter method is absolutely correct theoretically, but it is believed to rest on a more rational basis than the usual method, and, at any rate, it takes full account of the resonance effect, which the usual method absolutely fails to do.

In practice, the parallel running of synchronous machinery of all kinds is considerably influenced by the damping action of eddy currents, the effect of which cannot be easily taken into account in the graphical method of investigation which the author has given. Such damping action exists in all synchronous machinery, and is, in many cases, artificially increased by the use of solid pole-pieces, damping coils, &c. In ordinary cases it is probable that, by the use of such devices, sufficient damping can be obtained to render parallel operation workable even when fairly close to the conditions for resonance; but all such damping is objectionable, in that it involves continuous loss of energy, and it should, therefore, always be kept as small as the conditions of operation will permit.

If it be conceded that the phase displacement method of designing the rotating parts of generating sets for parallel working has no rational basis, it follows that great caution should be exercised in applying data obtained under one set of conditions to other cases in which the type of prime mover or other conditions differ. For instance, it is commonly stated on theoretical grounds that parallel running is facilitated by low frequency, owing to a smaller phase displacement being obtained with a given fly-wheel power, but the author does not consider that theory justifies this statement.

The conclusions arrived at in this article may be summarised as follows :—

1. The present practice of designing the rotating parts of direct-coupled generating sets for parallel running, so that the phase displacement on a load offering a constant torque shall not exceed a certain limit, is not justified by theory.

2. A more rational method of designing the rotating parts is to proportion them so that the characteristic fluctuation of output shall not exceed a certain limit.

3. The present state of the theory of parallel running does not justify the statement that parallel running is facilitated by low frequency.

WIRELESS TELEGRAPHY IN GERMANY.

By EMILE GUARINI.

It has been already announced in the Electrical Review (Vol. 50, No. 1,266, p. 341) that the German Government will shortly make an extensive use of wireless telegraphy, especially on the vessels of the Imperial navy and at different

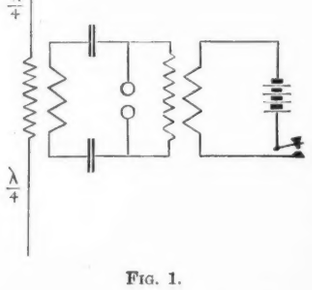


Fig. 1.

points along the coast. The two systems that will probably be adopted—Marconi's refusal to take part in the competition is well known—are that of M. Fernand Braun, professor at the University of Strasburg, worked by Messrs. Siemens and Halske, and that of Messrs. Slaby-Arco, which is worked by the Allgemeine Elektricitäts Gesellschaft, and which has been tried in China on the German battleships and elsewhere.

The Braun transmitter (Siemens & Halske) consists (fig. 1) of an induction coil, the secondary of which is in series with two condensers and the primary of a transformer, the secondary of which ends on the one hand at the antenna—

equal to $\frac{1}{4}$ of the length of wave—and on the other at another wire (*not connected to earth*) equal in length to the antenna. This wire can be replaced by a metal plate or wound in a spiral. The oscillator is placed in shunt at the terminals of the condenser—the secondary of the first transformer. The second transformer effects the transformation from low to high pressure. The receiver (Braun-Siemens and Halske, fig. 2) is, to a certain extent, the reverse of the transmitter—an antenna equal to $\frac{1}{4}$ of the wave length passes through the primary, of thick wire and wound with few spirals, of a transformer, and ends with a wire wound, say, $\frac{\lambda}{4}$, or at a metal plate. The secondary is connected with a wire wound, say, $\frac{\lambda}{4}$ or to a metal plate directly, on the one hand, and, on the other, with a coherer placed in circuit as usual. A condenser is connected in shunt with the terminals of the primary of the transformer, probably in order to accentuate at this point the production of a ventral segment of the intensity of the wave.

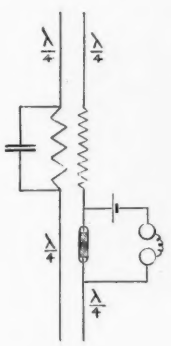


Fig. 2.

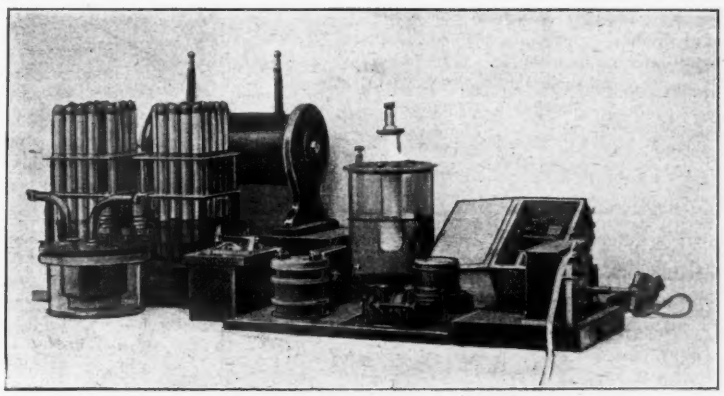


Fig. 3.

Fig. 3 represents the complete set of Braun transmitting and receiving apparatus. By means of this apparatus Messrs. Siemens & Halske have been able to communicate over very great distances, in particular between Heligoland and Cuxhaven—about 70 km.

The latest adaptation of the Slaby-Arco system is shown in figs. 4 and 5. The transmitter consists (fig. 4) of a circuit constituted as follows: Earth, self-induction coil, condenser, self-induction coil, earth. The antenna is connected with the ball of the oscillator, which is connected to earth through the self-induction coil. The receiver is similar. It is shown diagrammatically in fig. 5. An antenna ends at the earth directly, on the one hand, and on the other goes through a coherer and a condenser. The circuit of the coherer is completed by a battery and a relay, as is seen in the figure. Messrs. Slaby & Arco introduce between the antenna and the earth a self-induction coil, and between the antenna and the coherer a bobbin with a special winding of the Oudin unipolar resonator type, at the extremity of which, where the coherer is placed, the pressure is at its maximum (for the sake of clearness, we do not show in the figure the above-mentioned bobbins). By means of this system the Allgemeine Elektricitäts Gesellschaft has been enabled to communicate over considerable distances, in particular between Cuxhaven and Esbjey, in Denmark, a distance of 127 miles. Like the Marconi system, the Braun and the Slaby-Arco systems secure, *to a certain extent*, secrecy of communication by means of syntony, obtained, as we know, by placing the coherer at points where the pressure is at its maximum for a certain length of wave. The length of wave from the transmitter is made to vary by working on the capacity and the self-induction coil of the closed discharging circuit, which is closed metallically in the Braun system and by the earth in the Slaby-Arco system.

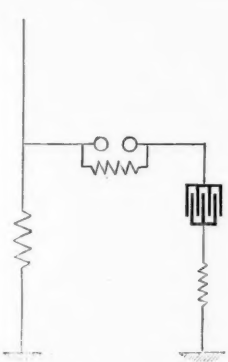


Fig. 4.

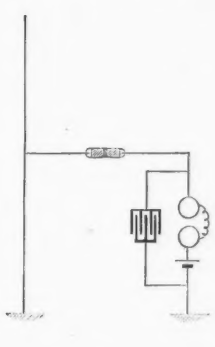


Fig. 5.

IS LIGHTNING OSCILLATORY?

There has been a considerable amount of controversy among physicists about the nature of the electric discharge in a lightning flash. Dr. Lodge has maintained that the conditions are the same as produce the oscillatory discharge in the Leyden jar, and that therefore the electric current in the lightning flash is oscillatory. Experimental evidence, however, has not lent much support to the oscillatory theory, and a recently published paper* by Dr. Walter, of Hamburg, shows that in numerous lightning flashes which he has photographed by a special apparatus, the discharge is not oscillatory, but intermittent and unidirectional.

It has long been known that a single lightning flash can be shown to consist of a number of separate discharges following the same path, by the simple device of moving the camera while a photograph of the flash is being taken. In these experiments the camera was moved by hand, and as the movement was irregular, no accurate estimate of the interval of time between successive discharges could be formed by measuring the distance between successive images. Dr. Walter has overcome this defect in the experimental method by rotating his camera at a uniform rate.

The photographic apparatus consisted of a camera mounted on a vertical axis, rotated at a uniform rate by clockwork. The connection between the axis and the camera was not rigid, but frictional, so that the lens of the camera could be directed by hand to the part of the sky where the lightning flashes were passing. A wide angle lens of the double anastigmatic type was preferably used, but good results can be obtained by an ordinary lens with a small stop. The plate used was 9 × 12 cm. (corresponding to our quarter plate), and two change boxes, each containing 12 plates, were included in the outfit. The observations were made from a small hut erected on the roof of a high building. The hut was provided with four hinged windows directed to the four points of the compass. Only the window from

* *Physikalische Zeitschrift*, III., No. 8, pp. 168—172.

which observations were being made, was opened, so that the observer was sufficiently protected from rain.

Fig. 1 is a photograph of a lightning flash taken by Walter's apparatus. It is evident that the flash consisted of three separate discharges. But the important point to be noticed is that the time interval between the first and second discharge is much less than the interval between the second and the third. When calculated out from the data of the apparatus, the time interval between the first and second discharges is found to be 0·042 second, and that between the second and third 0·11 second. This excludes the possibility of the discharges being oscillatory, because in that case the time intervals between successive discharges would have been equal. Another point to be noted is that a number of short branches shoot out from the line representing the first discharge, but none from the second and third. This curious phenomenon is explained by some interesting experiments on the formation of the electric spark of an induction coil, made by Walter in 1899.* It was shown by these experiments

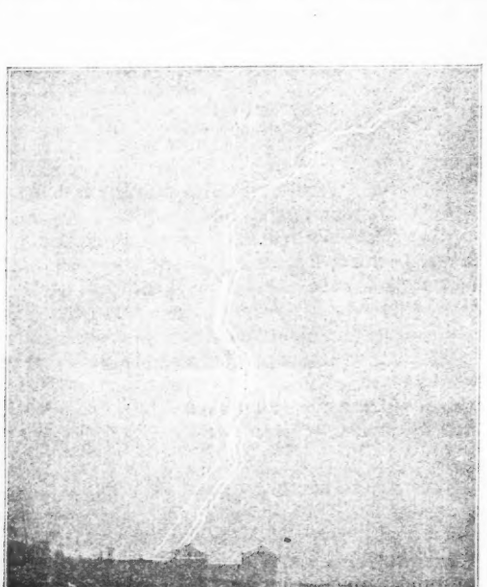


Fig. 1.—Photograph of Lightning Flash, showing three Separate Discharges.

that the electric spark does not jump across the air gap at a single leap, but by several progressive attempts, starting from both electrodes, like cracks made by driving wedges from opposite sides into a block of wood. Each blow of the hammer, corresponding to each impulse of E.M.F. from the induction coil, sends the cracks a little further into the wood till they meet, when a clear line of cleavage lies through the block of wood. Just in the same way the cleavages in the ether caused by impulses of E.M.F. in the coil, or in the electrified cloud, gradually approach till they meet, thus forming a conducting path through which the complete discharge takes place. All subsequent discharges follow this path, and hence the exact similarity in form of the paths of the successive discharges, as shown by the photograph. The branches are formed by the positive incomplete discharges while they are forcing their way through the dielectric to meet the negative discharges, on which, curiously enough, no branches are found. After the path has been completed the branches disappear as the line of least resistance is now through the completed path.

In some cases, Walter found as many as six separate discharges in one flash, fig. 2. The time intervals between these successive discharges are, as in the former case, very unequal. They are, as calculated from the photograph:—0·131, 0·068, 0·075, 0·119, and 0·103. Any regular oscillation of electric currents between the cloud and the earth is here out of the question.

Another significant fact shown by this photograph is that the second and sixth discharges are very much brighter

Fig. 2.—Photograph showing Six Separate Discharges in One Flash.

than the rest. With regular oscillations there ought to be a gradual falling off in brightness, due to damping.

An examination of the photograph shows that the double photograph of the landscape was due to these two brightest discharges. The multiple views of the landscape are often a valuable indication of the presence of multiple discharges, when the multiple discharges themselves, owing to their being concealed by a cloud or for some other reason, are not visible on the photograph.

Walter is of opinion that in almost all cases where a discharge takes place between a cloud and the earth the cloud is positive to the earth. He is willing to admit, however, that the positive discharge may in a few cases be from the earth to the cloud; but in that case the discharge shows no lateral branches.

Dr. Walter's investigations are not only of great theoretical interest, but they ought also to be of considerable value in the design of lightning conductors. The tendency of the positive discharge to strike out laterally, and the absence of this tendency in the negative discharge, form an unexplained phenomenon which must be closely related to the fundamental nature of electricity. It also appears to indicate that lateral discharges from lightning conductors only take place when a great resistance is interposed in the path of a positive discharge.

REVIEWS.

Primary Batteries. By W. R. Cooper, M.A., B.Sc. London: *Electrician* Printing and Publishing Company. Price 10s. 6d.

Time was when primary batteries were practically the universal generators of electric currents. The only engineers who used them were those connected with land and submarine telegraphy, to whom the cost of the energy supplied was of no moment.

With the advent of the dynamo, and the subsequent extension of electrical applications to all branches of engineering, the primary battery sank into a very subordinate position. A still heavier blow was administered when the accumulator arrived, and it seemed, for a while, as if primary cells must slowly disappear. But the danger has, in some senses, acted like a tonic. Many new and good forms have been designed in the last

* *Wied. Ann.*, Vol. 68, p. 776, A.D. 1899.

12 years, and we have further evidence of their vitality in the publication of a new book devoted entirely to them.

Mr. Cooper's work contains 317 pages, of which 40 are devoted to such questions as local action, polarisation, &c., 80 to the general theory, while the rest describe the construction, working, and testing of a large number of the commercial forms. The cells described are classified under the heads of (1) non-chemical cells and thermopiles, (2) one-fluid cells, (3) two-fluid cells, (4) dry cells, (5) standard cells, (6) carbon-consuming cells.

The general theory of voltaic action, and the thermo-dynamical equations of Kelvin and Helmholtz are very lucidly explained. The long controversy on contact force *versus* chemical affinity is fairly well summarised. But the reader who hopes to get a definite standpoint will be disappointed. Mr. Cooper is determined not to commit himself, and declares that the whole matter is largely a question of definition. This may be true, but there is no doubt that most important questions surround the whole subject, and are worthy of the varied work which has been done by the controversialists. Indeed, many of them will probably spring up again and lead to fruitful developments. One or two pieces of recent work are omitted. Thus, Galt's research on the heat of formation of alloys of zinc and copper, and still more, that of Baker on the same subject, ought to have been mentioned along with that of J. B. Taylor (p. 74).

Ionisation, electrolytic conductivity, osmotic pressure, and Nernst's electrolytic solution pressure are all expounded in a way which will make them easy to understand.

The section which describes the various cells is interesting, largely because it gives discharge curves of many commercial forms. These ought to give more precise ideas of their working powers than are generally possessed by those who use them.

In the case of the bichromate cell, there is a discussion of the use of commercial chromic acid instead of the salt, the conclusion being that the acid is preferable. The summary omits to notice one strong argument in favour of the acid—it does not permit the potassium chromium alum crystals to form. These are often very difficult to remove after heavy work. This section would have been further improved by a description of forms of bichromate which are used for heavy bell work and by some of the railway companies.

The account of various Leclanché cell forms is very good. Of dry cells much detailed information is given, and discharge data are tabulated.

The chapter on standard cells is one whose importance is already great and will probably increase. The construction, behaviour, and value of nearly all are fully described.

The last chapter, on carbon-consuming cells, ought to be carefully studied. The results up to the present are wofully disappointing, but the possibility of a direct production of electric currents from carbon is so important that every young electrical engineer ought to have some sense of the position. It ought not to be forgotten that in many ways a good primary cell is more efficient than most other devices, and if the element consumed were as cheap as carbon, the primary battery would leap into a largely extended use. On paper, it is possible for it to become a competitor with the engine and dynamo.

THE OUTSIDE LABOUR QUESTION.

By JAMES WHITCHER.

(*Continued from page* 584.)

It is outside work that suffers the brunt of the loss and inconvenience resulting from the untoward developments along these lines. From the point of view of economy and efficiency, the handy man should be a recognised and respected institution on outside contracts and work; but there is a strong and virulent intention abroad to crush him out altogether. A contractor for erection work of any kind, ought in reason to have full unfettered freedom to execute the multifarious items of the contract, in the way that seems most satisfactory to him. Sub-letting, particularly of trifles, with the consequent infliction of extra profits, is against all economics. A handy man, having two or three trades at his command, could help him through these difficulties with greater expedition and convenience generally, and in a more satisfactory manner to all concerned. It is the just and natural way of meeting the need; for it is the one most saving of waste, such as the undignified idling about of skilled men waiting to follow on other trades, or the other expedient of sub-contracting at the excessive rates inevitable. *Apropos* of this, we sometimes find, for example, engineering or electrical contractors, in the unfortunate predicament of having to let out such work, say, to the building contractor, without the least power of controlling the price. Often, indeed, there are most unjust stipulations to this effect in architects' and engineers' specifications.

It is not to be argued that a well constituted man cannot easily master more than one trade. Intelligent man is an animal of greater capacity than that. Besides, it is not as though it were manufacturing or continuous repetition work that were required of him. There the machine-like action, regularity, and certainty only acquired by narrow specialised efforts, may be essential; but here a broad adaptable kind of skill is called for. In fact, handy men of really useful type, are perfectly possible creations; and they are more valuable than specialists for the purpose, having a far better general idea of what is to be done, and how best to do it. Seriously, we must not lose the handy man; every effort should be made to preserve him, at least for outside work.

A great deficiency in most outside trades, is an efficient and comprehensive system of awarding credentials to the workmen. If such a system is advisable anywhere, it is so here. Close and effective supervision being so often impossible, credible assurance of proper skill and honesty in a man is especially necessary; yet it can seldom be obtained. Moreover, the very nature of the work makes a constant changing of men a necessary evil. Nothing like the continuous settled employment possible in a workshop or on stationary works can exist here. A large proportion of the workers in a trade must float about from employer to employer, as the fortunes of business fluctuate between them. Thus a double worth attaches to a recommendation honestly and judiciously made, in terms commonly understood in the trade; and it ought never to be denied when deserved. Likewise, the exhibition of full credentials should be an essential preliminary to employment. Haphazard methods of taking on men lead to incalculable loss—not so much, perhaps, in the mere loss occasioned by faulty work, bad timekeeping, and other dishonesties, as in the injury to reputation, and the spoiling of confidence and goodwill. A firm may spend years building up a connection, which can be shattered by a few bad workmen in a tithe of the time. A wise employer will do much to preserve around him a staff of known workers, rather than run the risk of dependence on casual assistance. 'Tis a sorry plight to be in to be forced by urgent need to take on any drunken rapscallion that offers; but that is often the fate of small firms. The remedy is to promote by combined efforts, some equitable scheme of interchanging men, and of drafting their credentials. It is in the interests of the men also to support such a movement; because it would practically ensure constancy of work to the good and skilful worker, and relieve him from the frequent coming into competition with the scum of his trade; which, of course, floating always on the surface, is readier to the scoop.

The direction and supervision of outside workers is of large consequence. Under the ægis of a model foreman all the difficulties we have been discussing go far to disappear. But the model foreman is a rarity, and in any case he would be wasted upon much of the work to be done. For there is no cutting him up into little bits and distributing; his continuous presence is the essence of his efficiency and power. The model foreman besides possessing a knowledge of his trades, at once intimate in detail and comprehensive in scope, must be a man of authority and tact sufficient for the culture of sweet settled contentment among his good workers, and for the sowing of thorny unrest amid his bad. He must be a rigid timekeeper and disciplinarian, decisive and just, and have a keen insight into various human natures and intellects; so that he may grasp the workings of each indi-

vidual mind under him, and promptly accommodate his direction and treatment to suit. A combination of all these talents is something to be prized, and is really for better things than the detail governing of a few men.

In fact, he is something that need not be reckoned upon in practice. It is necessary to compromise with simpler qualities, selecting those of greater service and least dispensable, and accounting for the others by other means. A good and real capacity to direct is one of those to be most sought for. It is not a common gift. Many men, particularly among the ranks of employers, over-estimate their ability in this respect; and blind to the real cause, they blame their men for faults which originate solely from bad and insufficient direction. Instructions ill put and ill understood are responsible for many disastrous failures; and there is not given to every man, either the power of lucid explanation, or the insight to see that he is understood. Viewed from some standpoints, the stupidity of man is phenomenal. The man doomed to lead in technics, has no idea, in the initial crudity of his experience, of how difficult it may be to be understood of modern makes of artisans and labourers. Afterwards he learns, and becomes from henceforth, crucified on the cross of explaining simple things to simpler minds.

To direct well, it is important to know and read the mind one is attempting to guide. One must be sure the instructions are assimilated, especially if one is a person of considerable authority. To such, men have a fatal habit of protesting they know, for fear they shall appear simple and stupid; and they trust to luck, or their chance of receiving supplemental information from others. Unless one can detect and guard against such trickery, it is better not to undertake the task of direction. Moreover, it is essential to be able, if need be, to direct in full detail. The man who can do things himself, and whose men know it, usually gets them done well, even when he doesn't take particular interest in them. It is comparatively seldom that he gets troubled with cock-and-bull stories to account for failures. On the other hand, the man whose practical knowledge is suspected, becomes a regular butt for them.

A good foreman should be treated with every consideration. He may need effective supervision, and keeping up to his work; yet it should not be forgotten that he is a person of trust, not a mere scapegoat, to be burdened with blame for every mishap, and scarcely thanked for success. If he is worthy, he must suffer a good deal of wearing anxiety over his work, and he scarcely needs vexing more. He should not be wearied by much overtime, nor deemed able to maintain proper vigilance for 11 or 12 hours a day. His authority should be stiffened by every reasonable means possible to his employer; and care should be taken not to undermine it by any unconscious act. In short, he wants help and encouragement, and generous incentive to put his soul into his work, and to be free, in reason, from overtaxing and rushing tactics that may put him off his balance. Rush your mechanical workers as much as you like, but spare your headpieces, if you would be smart and wise. Your ganger, of course, whose duties are mainly disciplinarian, does not come under these remarks. Keep your foremen's goodwill; don't have men with grievances about you; remove either the men or the grievances.

(*To be concluded.*)

CORRESPONDENCE.

Musical Glow Lamps.

Can any of your readers supply me with an explanation of the following phenomenon?

A 1-H.P. gas engine is driving a 50-volt dynamo supplying about 10 amperes for private house lighting. The armature of the dynamo is toothed and emits a loud hum. The whole plant is in an outhouse isolated from the main building. In a room at the other end of the house is a plain pendant with three lights and an opal shade. The engine and dynamo are quite inaudible in this room until the light is turned on, when by placing the ear close to the fitting the hum of the dynamo and the beat of the gas engine can be distinctly heard. This is evidently an electrical effect, as it is only perceptible when the current is on. I may add that the note which the opal shade gives when tapped is not in unison with the note of the dynamo. I shall be glad to have this explained if you consider it of sufficient interest for insertion in your "Correspondence" column.

E. Leslie M. Allen.

London, *April 12th*, 1902.

[The effect described by our correspondent seems to be akin to the reproduction of the hum of the alternator in alternating current arc lamps, &c. Perhaps there is a loose contact in one of the lampholders of the three-light pendant, which, if not causing an actual arc, produces a considerable local rise of temperature, which might account for the phenomenon.—Eds. Elec. Rev.]

500-Volt Electric Shocks.

From remarks made privately to me, with reference to my letter on electric shocks in your issue of 28th ult., I have evidently not made myself sufficiently clear. I do not claim to be a living example of the *incorrectness* of Ohm's law, nor do I wish to be taken as a close rival to the copper conductor. I am quite aware that the current will be regulated by the resistance in circuit. Therefore, perhaps the enterprising party who so kindly gave me the KW. flowing will make another effort, when I say that, I do not for a moment suppose that the No. 22 copper fuse was blown by current passing through my body alone, but by an arc set up by the same. The shock was received from the ends of a 35/40 flexible wire connected to a lampholder plug. This does not in any way alter my contention that the current passing was considerable (consistent, of course, with the high resistance in circuit), and to prove this, I may say that large blisters were raised at the points of contact, and the strands of the flexible wire visible in black lines for more than a week afterwards, which I am personally inclined to think would require more than the fraction of an ampere to accomplish. My intention was not to go into details of how the shock was received, but to endeavour to prove that a fatal shock *may* be received by contact with a lower pressure than 500 volts. I do not for a moment wish to convey the idea that 500 volts must therefore prove fatal, nor do I wish to say 220 volts alternating is very dangerous; but what I do say is, both are best left alone at times, and under certain circumstances, as I believe had I remained in circuit long enough, it would have proved fatal. I may add that at times I would handle the same circuit without fear of any serious shock. Should this meet the eye of the party who so kindly gave me the KW. as mentioned above, he will now be able to give me an amended estimate; but before putting him to the trouble, I would like to say the lowest or any estimate will not necessarily be accepted by me as correct, as I do not know, and I expect he is about as near as I am to, the actual value; but this is immaterial, as it seems to me the question is what is the lowest voltage that can, under *any* conditions, prove fatal?

W. F. Stamp.

London, *March 9th*, 1902.

As there seems to be an impression in some quarters that 500-volt circuits—power, not primary battery—are quite harmless, I should like to bear out Mr. Vezey's opinion.

I think that anyone who has had any experience with live 500-volt circuits, with a power house behind, will agree that they do demand a certain amount of respect.

I have had several unpleasant reminders myself, and seen some nasty accidents with 500 volts.

Testing Engineer.

Prof. Thompson on Patent Law.

Having been out of town, I have but just seen your issue of March 28th, and I find an Editorial Note in which there is a considerable misapprehension of the proposals I have made as to the amendment of patent law. I have certainly not proposed to extend the period of provisional protection to two years. My proposal is quite compatible with the entire

abolition of "provisional protection." What I want to see is the extension of the "exhibition clause" of the existing patent law from six months to two years, and its enlargement to cases of exhibition before any of the learned or scientific societies. You also misunderstand my reference to the late Prof. Hughes. As the law stood, and stands to-day, he had to choose between either patenting or exhibiting to a society. He deliberately chose the latter. What I urge is that no man ought to be put into this dilemma: that the circumstance of his having exhibited his invention at a certain date to a scientific society, ought not to invalidate his subsequent right to apply for a patent for the same; but, that on the contrary, the very fact of such exhibition ought, as in the United States, to be accepted as evidence of his having actually been at that date in possession of the invention which he seeks to patent. A man does not lose his copyright in a book because he publishes it. Then why should the law disallow his copyright to an invention because he publishes it? In one case the law very equitably assumes that a man's brain work is his own. Why, in the other case, sh uld it proceed on the inequitable assumption that it is not his own?

Silvanus P. Thompson.

West Hampstead, *April 12th*, 1902.

Electric Wiring Methods of To-day, with Special Reference to Conduit Systems.

Under the above heading, Mr. Bathurst, in your last issue, now appears as the champion of a special quality unlined tube, to wit, "Armorduct," which he modestly refrains from offering as the solution of the wiring question, while extolling its advantages "to show the possibility of good conduit construction at a price but slightly higher than that prevailing for the cheap work now being done."

Mr. Bathurst at length acknowledges that his commercial struggles to secure recognition of lined iron pipe have taught him that the requirements of scientific perfection must be blended to suit prevailing commercial conditions, hence his conversion to the unlined pipe, which, in days gone by, he was wont to portray as fused by internal arcs and disfigured by unsightly burrs, not to mention endless other objections to its use in installation work, many of which are set out in his paper "The Prevention of Fires Due to Leakage of Electricity," in which he severely criticises the views of those advocating the use of the plain iron pipe, telling them that their main argument of low first cost does not hold if regard is given to uninterrupted service and to the future.

Truly, one is compelled to agree with his remark that "change and progress in the electrical world are irresistible" when they show Mr. Bathurst the crookedness of his former leanings, and induce him to forsake the "idealism" of the lined for the "realism" of the unlined; or, in the language of business, he has learned that it is more remunerative to supply what is actually demanded than what in his opinion should be required.

There is a second lesson, one which Mr. Bathurst has not yet learned, viz., that it is not only unnecessary but unwise policy to depreciate the value of successful competing systems in order to extol by contrast the virtues of that which happens for the time being to be his special system.

I hold no brief from the Birmingham rolled-steel tube manufacturers to defend their policy in manufacturing tubes for conduit wiring work, but I fail to see any valid reason why such tube, when used for this purpose, has not every bit as much right to be designated "electric conduit" as a glorified gas tube has to be designated "armorduct."

The supreme contempt Mr. Bathurst intends to convey by the words "Brummagem-made" close-joint tubes is not apparent to anyone who knows that Birmingham is the seat of the industry, and whatever "Brummagem-made" may imply when used in connection with certain manufactures of that city, it can only have one meaning when applied to iron and steel manufactures, and that is far removed from what he intended to convey.

Mr. Bathurst's next remark that the seam in close-rolled tube is brought up so close that when painted it is "likely" and "liable" to deceive inexperienced buyers is too absurd to be taken seriously; but it is distinctly unfair to make such insinuations without a shadow of evidence to support the idea that manufacturers ever had any such intention. But even presuming an inclination to deceive, the folly of conducting business on such lines is too apparent for a moment's consideration.

Mr. Bathurst proceeds to contrast the cold bending of the rolled tube with that of his special gas tube, and, needless to say, his verdict is in favour of the latter, which, although made of a "special quality steel," can, he tells us, be readily bent cold up to 1½ in. internal diameter!

Space will not permit of my replying to all the alleged defects of rolled steel tubing for conduit wiring, but its four years' record is not altogether a bad one; and as we live and learn by experience, it may be that in the not far distant future Mr. Bathurst will find that the "requirements of scientific perfection" must yet further bend to the practical requirements of to-day.

L. M. Waterhouse, A.M.Inst.C.E.

Outside Labour.

Mr. Whitcher's masterly and altogether just denunciation of the wholesale iniquities of those engaged in outside electrical work is timely in the extreme, and, as an unfortunate member of the class alluded to, I shall heartily welcome any practical result which may be effected by its publication. The amount of corruption exercised in the directions named is sufficient to appal any right-thinking and conscientious workman.

I should like to emphasise, through the medium of your paper, the extreme perniciousness of the example set to the *lads* engaged in the trade. Most boys on leaving school are imbued with a more or less keen veneration for honour, but this is almost inevitably compelled to succumb to the power of the untoward influences brought to bear upon them by the dishonest workmen with whom they are called upon to associate.

I well remember my own experience in this direction. Brought up by conscientious, upright parents, I entered upon my work with every determination to do the right thing by my employers. The consequence was that I was soon regarded as a "little prig," and every organised effort was made to undermine my resolutions. This was done with the approval, nay, positive assistance of the foreman, until my life was more or less a burden to me. Familiarity with these malpractices slowly, but surely, led to a contempt, *i.e.*, indifference, and, had I not pulled myself up by a supreme effort, I might soon have out-Heroded the veriest Herod amongst them.

Something ought surely to be done to make it less difficult for apprentices to maintain their integrity.

Harry Payne.

London County Council Contracts.

A few weeks back you published a report of a meeting of the above Council, at which a large contract for steel rails was given to a Belgian firm. Two of the members of the Council implied that the cheapness of the Belgian rails, as compared with English, was due to the wages clauses attached to the conditions of contract which stipulated for trade union rates, and fair conditions of production. One member stated that the British employer was the goose that laid the golden eggs, and the eggs were the workmen's wages. That trade unions are driving the work out of the country, by compelling the masters to pay a minimum standard wage, seems to explain why the contract went abroad in a delightfully simple manner. This attitude was also taken up by one of your contemporaries.

The altogether unfair and biassed deductions on this and all other questions relating to municipal work, the championship of vested interests, without due regard to the interests of the people as a whole, the holy horror of anything which appears to abrogate that first (?) great law of business ethics, viz., "freedom of contract," as indulged in by the electrical press, calls for a few brief but plain facts on the other side.

Now the reason for this order going abroad has nothing whatever to do with labour's wages. It is chiefly

due to the excessive railway rates levied by monopolist railway companies, and the excessive royalties paid to non-producers in England, as compared with those in Belgium.

In 1896 the British Iron Trade Association issued a report dealing with these questions, which conclusively showed that the wages paid in Belgium and Germany were practically equal to those paid in England, and that the conditions of labour were the same. This, after a deputation had personally investigated matters for themselves. Then, as to carriage: here monopolist railway companies charge 10s. per ton for 130 miles, while in Belgium this distance would cost about 3s. 6d. The same applies to shipping charges. Goods sent from Antwerp to Calcutta *viâ* London were charged 10s. per ton, while the same class of goods sent direct from London to Calcutta were charged 15s. 9d. per ton.

In the case of mineral royalties, the facts range themselves on the same lines.

Sir Christopher Furness, in the March *Pall Mall Magazine*, gives some startling facts on this question. The royalties on steel rails are as follows:—11d. per ton in France, 8½d. per ton in Germany, 5s. 6d. per ton in England. The royalty on *coal* is also very much higher here than abroad, as the report above referred to shows.

Now, taking the figures supplied in this report, and applying them to this County Council contract for steel rails, we find that the carriage and mining royalties paid on Belgian rails delivered in London would be about £975, while on British goods, if obtained from the Cleveland district, they would total £6,750, a balance against British rails on carriages and royalties alone of £5,775. This goes to explain a large portion of the £8,721 10s. 8d. in favour of the Belgian rails, and this is the burden England is saddled with, not a burden imposed by the wealth producers as so often stated. We *must* keep the work in England, and I suppose the electrical press and the members of the Council referred to would suggest that to do this we must still keep on paying these parasitic royalties and heavy freight charges; but cut down the workers' wages till we can compete successfully with foreigners. 'Tis written "The labourer is worthy of his hire," but, says the business man, not when he interferes with "freedom of contract" between his master and himself, which is a very great crime. Royalties paid to idleness and burdens inflicted by railway companies are, of course, nothing.

Justice.

The Crawford-Voelker Lamp.

I note your comments in the current issue of the Electrical Review with respect to the Crawford-Voelker lamp. In the first place, I desire to say that the Crawford-Voelker lamp is not at the present time being manufactured at a factory, but is the product of a laboratory. It will be several months before these lamps can be supplied to the trade.

The reason why we have not been able to furnish lamps as arranged for with you is because we have been manufacturing a large quantity for tests in another country. These lamps are of a different voltage from what we expected to supply to you.

Owing to the great demand for 200-volt lamps in this country, it has been thought desirable to have the lamps for your test of this voltage. The demand on us for lamps to carry out our contracts elsewhere, together with the illness of Mr. Voelker, and the very limited facilities for turning out lamps at our laboratory, furnish an explanation which I think is in every way reasonable. It is the intention, notwithstanding the fact that you have seen fit to unfavourably criticise the proprietors of the lamp, to give you every facility for testing the same.

I greatly regret that before making the comments of the nature shown by your article, you did not either call me up on the telephone, or write to me respecting the matter, as I should have been very glad to have given you an explanation.

We appreciate the interest of the Electrical Review, and the value of its opinion, but the work in connection with the development of the lamp having cost a large sum of money up to date, we have felt that it is quite proper for us to first carry out the contracts made with parties who purpose marketing the product. We will be prepared, however, for a check test with Colonel Holden and yourselves in the very early future. The test of the 110-volt lamps could have been carried out at any time within the last three months, and, in fact, other tests on this voltage have been concluded.

F. Z. Maguire.

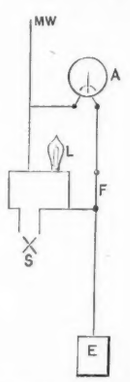
London, *April 15th*, 1902.

[Our correspondent's "intentions" are manifestly good; what we have complained of is the lack of performance. As to the propriety of carrying out the contracts referred to, we offer no criticism; we are concerned only with the question—will the said parties market the *lamps*, or will they market *shares in a limited company?* In the latter case, we once more urge the importance to the public of an authoritative investigation into the merits of the lamp before any fresh prospectus is issued.—Eds. Elec. Rev.]

Earthing the Middle Wire.

I should be glad to have the opinion of your readers on the following method of "earthing" the middle-wire of a three-wire system.

The earth connection is made through an ammeter in series with a fuse, the two being shunted by a lamp, which can be short-circuited by a switch (see figure). If an



M W, Middle wire; A Ammeter; L, Lamp; F, Fuse; S, Switch; E, Earth plate.

earth develops on the system, which would damage the ammeter, the fuse blows, and the connection to earth is maintained through the lamp, which will indicate a bad fault by lighting.

If it is desired to burn out the fault, the switch is closed, which puts the middle wire direct to earth.

H. J.

Overhead Mains.

Although I have been a constant reader of your valued paper for many years, I have never ventured to air an opinion on the various correspondence appearing therein from time to time. In this case, I, like Mr. Hadfield, have been specially interested. I can well remember Mr. Roberts commencing his career as an electrical engineer, and great credit is due to him for the manner in which he has worked and risen. If it is the same Mr. Harriss, I can remember his coming to Eastbourne to take charge, for the first time, of a lighting station in 1888; and, lastly, I have most vivid recollections of Mr. Hadfield and Durban electric lighting by overhead mains (old style). Evidently Mr. Roberts has not experienced anything respectable in the shape of a thunderstorm, or he would not be quite so enthusiastic on bare overhead wires. One really decent storm will change his opinion, as it did mine; and he would have done well to have taken his cue from Mr. Hadfield. My experience with overhead wiring commenced in 1884, and I am at work on it now. During the interval I have seen and superintended the erection of many scores of miles, and places that Mr. Roberts refers to in the sweeping word "colonial," such as Johannesburg, Cape Town, Durban, Melbourne, Sydney

Broken Hill, Hobart, Launceston, Dunedin, and many other places too numerous to mention have come under my notice, and I cannot call to mind one instance of town lighting by means of overhead bare or covered wires that has appealed to my mind as satisfactory, more especially in the Colonies. On the other hand, I have seen some capital installations of overhead systems on many mines and works, where appearances count for nothing, distances are short, constant supervision is maintained, and ample spares are kept to meet the ravages of storm and lightning, which is answerable for more bad language amongst electrical engineers in the Colonies than anything else I know of, and no doubt Mr. Hadfield would have to paint his thrilling stories with bad language, or they would not be realistic—I should mine.

The motto I should advise Mr. Roberts to adopt is, "Where possible, put them underground."

Thomas H. Parker, M.I.M.E., M.S.A., &c.

Newton Hall, Middlewich,
April 16th, 1902.

Electric Welding.

A correspondent seeks information respecting the use of the electric arc for filling up holes in steel castings. "Where is the process in use? Can it be successfully applied in the case of cast-iron and gun-metal?"

LEGAL.

Isaacson and Wife *v.* New Grand Theatre.

This case came before a Divisional Court of King's Bench, composed of the Lord Chief Justice, Mr. Justice Darling, and Mr. Justice Channell, on Wednesday last week, on the appeal of the plaintiffs from the judgment of the Deputy-Judge of the Westminster County Court, giving judgment for the defendants. Mr. Moyses appeared for the appellants, and Mr. Minton Sennhouse for the respondents.

It appeared from the statement of Mr. Moyses, in opening the case, that the action was brought by the plaintiffs, the parents of a young man who was killed in the course of his employment, under the Employers' Liability Act, combined with Lord Campbell's Act. The learned counsel stated that the New Grand Theatre at Clapham Junction was the property of, and was worked by the defendants. The action was heard on December 16th, and after a hearing which occupied the whole day, the learned Deputy-Judge held on a submission made on behalf of the defendants that the deceased man was not a workman within the meaning of the Act. That was the only point involved in the appeal. The short facts were these:—The New Grand Theatre Company had their own generating machinery, by which they generated their own electric light. The deceased man, with two others, a stoker and assistant engineer, was left in charge of the machinery, his wages being £2 2s. a week, plus overtime. There was over the deceased man a man named Rayner, who was the superintendent and manager of the engineering works of the theatre, and also of another theatre which belonged to the defendants. The deceased man met with his death by falling down a sump or hole full of scalding water during the course of his employment. The father of the deceased man was the stage manager of the theatre, and he and wife brought the present action to recover damages from the defendants under the Act, he having contributed a weekly sum to the support of the home. At the trial, Rayner, who was an electrical engineer, was called, and said that the deceased man was working under his orders in connection with the electrical or engineering works at the theatre. He engaged the deceased man as a practical fitter with electrical knowledge. The learned counsel said that at the trial he was taken by surprise when the point was taken by the defendants, after the plaintiffs' case was closed, that the deceased man was not a workman within the meaning of the Act. The learned Deputy-Judge declined to allow Mr. Rayner to be re-called to explain what the duties of the man were, and would not allow the case to go to the jury at all. He submitted that the Deputy Judge was wrong in not allowing the case to go to the jury. He contended that the deceased man came within one of the definitions of "journeyman artificer or handicraftsman," in the section of the Act, and therefore his parents were entitled to recover compensation for his death.

The Lord Chief Justice observed it did not follow that because a man was a competent engineer and in charge of engineering works he did not come within the terms of the Act.

Mr. Justice Darling said he noticed from the evidence of Mr. Rayner that that gentleman said that the deceased man was a practical fitter with electrical knowledge, and that if he (Rayner) pointed out anything for the man to do he would do it. His Lordship did not think that the learned counsel could have anything much stronger than that statement in support of his contention.

Mr. Sennhouse, in support of the judgment in the Court below, submitted that the deceased man did not come within the terms of the Act, as all the manual labour was done by the stoker and others, and the deceased man only superintended.

In the result the Lord Chief Justice, in giving judgment, said he expressed no opinion of what the ultimate result of the case might be, but he did not think there was sufficient evidence to enable the Deputy-Judge to hold that the deceased man was not a workman. He thought, therefore, it was not possible for them to say that the learned judge was right in coming to the conclusion that there was no evidence to go to the jury, and in order that there might be a real investigation as to what the position of the unfortunate man was, the case must go back for a new trial. The costs of the appeal and of the first trial to abide the result of the second trial. Mr. Justice Darling and Mr. Justice Channell concurred.

British Power, Lighting and Traction Company *v.* Gardner Bros.

In the York County Court last week this action, brought to recover from defendants, who are electrical engineers, of Burton-on-Trent, the value of a set of accumulators, &c., was heard before Judge Templer. Mr. R. H. V. Wragge, who appeared for the plaintiffs, said that on December 10th, 1900, Mr. John Geo. Dixon, of Sheffield, a traveller in electrical appliances and agent for plaintiffs in Sheffield and district, obtained from one of the defendants, who were constructing a battery at Swinton, an order for a set of 33 accumulators, the price agreed upon being £27 10s. The articles were supplied, but subsequently the battery being out of order, plaintiffs sent over a man to put it to rights, and for this they sought to recover a further £5. Plaintiffs alleged that the cells they supplied had not been properly connected by defendants, which was the cause of the mischief. Defendants, on the other hand, contended that the accumulators did not do their work properly.

According to the report of the case in the *Yorkshire Herald*, evidence was given by J. G. Dixon, the agent through whom the order was given, and he said that any electrical engineer who knew his business ought to have been able to fix the battery without instructions. The accumulators could not have got into such a condition if they had been properly used.

Samuel Schanschieff, employed by the plaintiff firm, said the battery was not erected right at all, and there was no tester anywhere about it. He had never known anyone work a battery like this without a tester. If the plates had been suspended properly they would have worked all right.

Sidney Cooper, called for the defence, said he did not put the accumulators together as they should have been, but it did not affect the working. He maintained that the work was done properly. The owner of Swinton Hall was coming on them for compensation. No instructions were sent with the cells.

His Honour: What do you say is the cause of the plates going wrong? Witness: Bad construction. Mr. Wragge: On your part? Witness: No, on theirs.

His Honour: You constructed the cells badly, undoubtedly. You did not know the way to put them up; you put them up all wrong, and then complained to the firm who made them.

Mr. Wragge was going to address the Court, but his Honour said he need not do so.

After hearing Mr. Richardson on the point whether he had jurisdiction in the case, his Honour said the case was, on the merits, practically an undefended action. The defendants could not throw the blame on the plaintiffs, because, when pressed, they actually offered to pay practically the whole amount. If anyone was to blame it was Mr. Gardner, who had taken the responsibility of putting these things together without having the necessary technical knowledge. The effect was disastrous. He would give judgment for £32 10s. with costs, and dismiss the counterclaim (for £50) with costs.

PARLIAMENTARY.

Electric Lighting Provisional Orders Bill (No. 3).

On 11th inst. Electric Lighting Provisional Orders Bill (No. 3) was before the Examiner of Standing Orders, and the Standing Orders were found to have been complied with. The following provisional orders are confirmed by the Bill:—

Abram.—Order granted to the Urban District Council of Abram, in the county of Lancaster.

Holyhead.—Provisional order granted to the Urban District Council of Holyhead, in the county of Anglesey.

Hucknall Torkard.—An order granted to the Urban District Council of Hucknall Torkard, in the county of Nottingham.

Leyland.—Grant to the Leyland Urban District Council, in the county of Lancaster. Undertakers are allowed to charge 13s. 4d. for any amount up to 20 units, and 8d. per unit over that amount.

Louth.—Provisional order granted to the Mayor and Corporation of the Borough of Louth in the County of Lincoln.

Penrath.—This is an order amending the Penrath Electric Lighting Order, 1898, and extended the time for the purchase of the undertaking by the local authority from 28 years to 38.

Saddleworth.—Provisional order granted to the Urban District Council of Saddleworth in the West Riding of the County of York. Clause 8 gives special power for the transfer of the undertaking to any company incorporated by any Act of this session relating to the Saddleworth and Springhead Tramways.

E

Springhead.—Order to the Urban District Council of Springhead in the West Riding of the County of York. This order contains a similar clause to that in the Saddleworth order, giving power to transfer to a company.

Tyldesley with Shakerley.—Order granted to the Urban District Council of Tyldesley with Shakerley in the County of Lancaster.

West Loughton.—Grant to the Urban District Council of West Loughton in the County Palatine of Lancaster.

Electric Lighting Provisional Orders Bill (No. 2).

Electric Lighting Provisional Orders Bill (No. 2) confirming certain provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, came before the Examiner of Standing Orders of the House of Commons on 11th inst, and the necessary formalities were found to have been complied with. The Bill referred to the following orders:—

Beeston.—Granted to the Urban District Council of Beeston, in the County of Nottingham. The undertakers are authorised to charge 11s. 8d. for any amount up to 20 units, and for each unit over 20 units 7d.

Carnarvon.—Order granted to the Corporation of Carnarvon in the County of Carnarvon.

Eston.—Provisional orders granted to the Urban District Council of Eston in the North Riding of the County of York.

Hebden Bridge.—Order granted to the Urban District Council of Hebden Bridge, in the West Riding of the County of York. Undertakers are authorised to charge 13s. 4d. for any amount up to 20 units, and for over 20 units, 8d.

Mytholmroyd.—Order granted to the Urban District Council of Mytholmroyd, in the West Riding of the County of York.

Otley.—Grant to the Urban District Council of Otley, in the West Riding of the County of York.

South Bank in Normandy.—Order granted to the South Bank in Normandy Urban District Council, in the North Riding of the County of York.

Stockton.—A grant to the Rural District Council of Stockton, in the County of Durham.

Thornaby-on-Tees.—Provisional order granted to the Mayor and Corporation of the Borough of Thornaby-on-Tees, in the North Riding of the County of York.

Tipton.—An order granted to the Urban District Council of Tipton, in the County of Stafford. Undertakers are authorised to charge 10s. for any amount up to 20 units, and for each unit over 20, 6d.

Standing Order Proofs.

On Monday the following amongst other Bills came before the Examiner of the House of Lords for proof of Standing Orders:—Brighton and Rottingdean Seashore Electric Tramway; Leicester and Warwickshire Electric Power; National Telephone Company (Kingston-upon-Hull) and National Telephone (Manchester Area). In all cases Standing Orders were found to have been complied with.

South Wales Electric Power Bill.

With respect to the additional clause which the South Wales Electrical Power Bill desire to add to their Bill of this session, the Standing Orders Committee of the House of Commons has reported that this may be done provided that the Select Committee which considers the Bill think fit. The clause gives the company power to acquire provisional orders granted to local authorities.

Mexborough and Swinton Tramways.

The Mexborough and Swinton Tramways Bill, which was found not to have complied with Standing Orders, came before the Standing Orders Committee of the House of Commons on 11th inst., when it was decided that Standing Orders might be dispensed with, and the parties be allowed to proceed with their Bill.

Hastings Tramways Bill.

This Bill, which seeks to empower the Hastings Tramway Company to construct an extension tramway in the Borough of Hastings, and for other purposes, came before the Standing Orders Committee of the House of Commons on Friday; and it was decided that the parties should be allowed to proceed if the power to construct the extension was struck out. The Bill will only authorise the company to make alterations of existing lines, raise additional capital, &c.

London United Tramways.

The Standing Orders Committee of the House of Commons has reported that Standing Orders should be dispensed with in the case of the London United Tramways Bill, and that the parties be permitted to proceed with their Bill provided that Tramways Nos. 1, 2, 3 and 8 be struck out of the Bill. The lines which will thus be abandoned are a line 2 miles 6 furlongs long, from Hammersmith Broadway to the Harrow Road; a line 7 furlongs long, from the Shepherd's Bush Road, Hammersmith, to have joined No. 1 line; a line 2 miles 4 furlongs in length, commencing in Uxbridge Road and terminating in the Edgware Road; and a line 1 mile 5 furlongs long, commencing at Kingston Hill and terminating at Beverley Bridge, in the boundary of the County of London.

Birmingham and Midland Tramways Bill.

In the case of this Bill, which came before the Standing Orders Committee, in consequence of Standing Orders not having been complied with, it has been decided that the parties be allowed to proceed, provided that Tramway No. 1 be struck out, and also a number of tramways in the Oldbury District unless the consent of the District Council of the parish be proved before Committee.

Exeter and District Tramways Bill.

It has been decided by the Standing Orders Committee of the House of Commons, that the parties in the Exeter and District Tramways Bill be allowed to proceed with the measure, provided that Tramways Nos. 1, 4, 5, 8, 9 and 10, and so much of Tramways Nos. 2 and 3 as lie within the boundaries of the City of Exeter be struck out.

South Shields, Sunderland and District Tramways Bill.

The Standing Orders Committee have reported that the Standing Orders should be dispensed with in the case of the above Bill, and that the parties be permitted to proceed.

Newcastle-upon-Tyne Corporation Tramways.

It has been decided by the Standing Orders Committee of the House of Commons that the Newcastle-upon-Tyne Corporation Tramways Bill be allowed to proceed providing that the power to construct a double line of tramway, 1 mile 6 furlongs and 0·70 chain in length, partly situated in the parish of Coxlodge and partly in the parish of North Gosforth be struck out.

Metropolitan District Railway Bill.

On Monday Mr. Parker Smith presided over the Court of Referees to consider applications for *locus standi* before the Select Committee in the case of the Metropolitan District Railway Bill, which has for its object the conferring of powers on the company to electrify certain railways, to extend the time for the completion of certain railways, and the compulsory purchase of land, and to constitute the railway authorised by the Metropolitan District Railway Act, 1897, a separate undertaking.

Mr. G. Fitzgerald, who appeared for the Ecclesiastical Commission, argued that his clients were entitled to a *locus* with regard to the clauses dealing with the extension of time. They were the owners of a large amount of property abutting on the railway at Westminster, and they wished protection against damage.

Mr. Clode, on behalf of the promoters, submitted that the petitioners would be in no different position than they had been for the last 30 or 40 years, for no more vibration would be caused by the electric motor than by a steam engine.

After consideration, it was decided that the Ecclesiastical Commission should be allowed a *locus* as far as Clause 40 of the Bill was concerned.

Mr. Freeman, K.C, stated the case for a *locus* on behalf of the London County Council. As the authority for the widening and alteration of streets, he submitted that the Council should be entitled to be heard with regard to the placing of tube railways.

Mr. Clode said that, so far as mains, sewers and electrical lines were concerned, he raised no objection to the Council's *locus standi*, but he objected to them having any *locus* on such a matter as advertising on buildings.

The Court granted a *locus* to the County Council with respect to Clause 5 (Power to lay cables) and Clause 12 (Power to acquire lands for general purposes).

A claim by the Middlesex County Council to appear as the owners of the Westminster Guildhall was allowed.

The Court declined to allow the promoters of the North-East London Railways (Nos. 1 and 2) Bill to appear against the Bill.

North Metropolitan Tramways.

On Monday the Court of Referees sat to consider the claim of the London County Council for a *locus standi* before the Select Committee on the North Metropolitan Tramways Bill, but there was no appearance on behalf of the petitioners.

L.C.C. (Tramways and Subways) Bill.

The Court of Referees, presided over by Mr. Parker Smith on Monday, decided to allow a *locus standi* to the Great Northern and Strand Railway Company against the L.C.C. Tramways and Subways Bill.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending April 16th, 1901.		Week ending April 15th, 1902.	
Alexandria	Value £186	Adelaide	Value £263
Amsterdam	132	Aden. Teleg. instruments	150
Bombay	60	Amsterdam	45
Brisbane. Teleg. cable	617	Auckland	3,193
Buenos Ayres	1,288	Bombay	253
,, Teleg. wire & mat.	1,402	,, Teleg. mat.	67
Calcutta	282	,, Teleg. instruments	111
Cape Town	527	Calcutta	1,331
Demerara	27	Cape Town	413
Dominica	37	Channel Islands	163
Durban	2,544	Colombo	52
Gibraltar	65	Durban	967
Hamburg	20	Fremantle	1,801
,, Teleg. mat.	200	Ghent	108
Hobart. Teleg. cable	248	Gibraltar	159
Hong Kong	87	Hamburg	40
Malta	56	,, Teleg. mat.	800
Nagasaki	107	Hobart	122
New Orleans	64	Hong Kong	22
Otago	693	Liban	310
Sydney	50	Melbourne	730
,, Teleg. mat.	57	Nagasaki	120
,, Teleph. mat.	378	Perth	165
Wellington	216	Port Elizabeth	1,054
		Port Said	47
		Rotterdam. Teleg. mat.	250
		St. Petersburg	60
		,, Teleg. mat.	500
		Shanghai	346
		Singapore	121
		Stockholm. Teleg. wire	793
		Sydney	1,248
		Tokio. Teleph. cable	989
		Wellington	1,146
		Yokohama	2,882
Total	£9,593	Total	£20,808

Foreign Goods Transhipped.

Hamburg. Elec. goods	Value £42	Bremen. Elec. apparatus.	Value £103
Trinidad. Elec. mat.	137	Paris. Elec. goods.	160
Total	£179	Total	£263

Bankruptcy Proceedings.—Under the failure of Frank Rayden, one of the promoters of the New Imperial Electric Lamp Company, Limited, the debtor attended last Friday before Mr. Registrar Brougham at the London Bankruptcy Court for public examination upon accounts showing liabilities £1,793 against assets £137. In the course of his evidence the debtor stated that he was a hop factor, and had carried on business under the style of Rayden and Co., at 52, High Street, Borough. In June, 1891, he assisted in the promotion of the New Imperial Electric Lamp Company, Limited, which was formed with a nominal capital of £3,000 to work an agency for the sale of electric lamps. Witness was appointed and remained a director of the company until the receiving order was made against him. He attributed his failure and insolvency to a loss of £250 sustained in connection with the before-mentioned company, to bad debts, and generally to the excess of expenses over profits.

At the same sitting the case of John Hervey Redgrave, electrical engineer, Regent House, Regent Street, W., and New Barnet, was mentioned in relation to the public examination. Mr. Grey, Official Receiver, reported that the debtor had absconded. A warrant had been issued for his arrest on a charge of obtaining money by fraud, but to the present the police had been unable to secure him. Under those circumstances, he asked for an examination to be adjourned *sine die*. His Honour made the order in those terms. Full particulars of the case have already appeared in these columns.

Dissolutions and Liquidations.—The British Electric Meter Company, Limited, is winding up voluntarily, with Mr. F. S. Springett, of 146A, Queen Victoria Street, E.C., as liquidator.

A meeting of the Fowler-Waring Cables Company, Limited, is to be held at Winchester House, E.C., on May 14th, to hear an account of the winding up from Mr. J. A. Blackwood, the liquidator.

A meeting of the New Motive Power Company, Limited, for a similar purpose is to be held at 15 and 17, Eldon Street, E.C., Mr. J. W. Roberts, liquidator.

Mr. R. Peters, the Receiver for debenture holders, and liquidator of Millington, Everitt & Co, Limited, manufacturing electricians, Cambridge, having received an offer to purchase by private treaty the whole of the stock-in-trade, machinery, plant, letters patent, goodwill, fixtures, furniture and utensils belonging to the company, a meeting of the creditors was held at the Lion Hotel, Petty Cury, Cambridge, on Monday, 14th inst., to consider whether the offer should be accepted, or whether the assets be submitted for sale by auction on Wednesday, the 16th inst., as previously arranged. We learn that the sale was completed by private treaty.

Messrs. J. K. Rogers, J. F. Rogers and T. J. Stables (Rogers Bros. and Stables, mechanical and electrical engineers, Heckmondwike and Cleckheaton) have dissolved partnership. Messrs. J. K. and J. F. Rogers will continue the business and attend to debts.

Books Received.—"Bibliography of the World's Municipal Literature," by Robert C. Brooks. London: P. S. King & Son.

"Papers and Reports relating to Mineral and Mining." Wellington: By authority, John Mackay, 1901.

"Motors and Motor-driving," by A. C. Harmsworth and others. London: Longmans, Green & Co., 1902. 9s. net.

"Fire Tests with Doors, No. 68 and 70." London: The British Fire Prevention Committee, 1902. 2s. 6d. net each.

Boiler Covering.—The Mica Boiler Covering Company, Limited, of 35, Queen Victoria Street, E.C., are supplying their mica flexible and cast coverings for pipes and boilers, also their fireproof cement. A very interesting pamphlet of some 50 pages has been brought out by them, in which the merits of the covering are stated, and a report by Prof. S. P. Thompson is quoted, also one by Prof. D. S. Capper, in which is stated the result of a series of experiments carried out to compare at high temperatures the efficiency of Michell's covering with other lagging materials in common use. Prof. Capper says that he is satisfied that "mica" lagging possesses very substantial advantages, "both as an efficient non-conductor, and as a practical easily handled covering, over all other laggings with which I am acquainted, and best fulfils the conditions of a really good lagging." Prof. Thompson has formed the opinion that the invention is "one of sound commercial value," capable of developing into an important and lucrative industry.

Catalogues and Lists.—Messrs. J. Carter, Sons & Co., of New Bailey Street, Salford, Manchester, have sent us a copy of the tool section of their catalogue. Numerous engineers' sundries and machines are described and priced. Screw threads, screwing machines, pipe cutters, lathes, vices, smiths' hearths, and a hundred other things are detailed.

Some illustrated lists of devices for Coronation illuminations have been received from the Electrical Maintenance and Accessories Syndicate, Limited, of 12, Peter Street, Manchester. Crowns, letters, flower garlands are shown.

Messrs. Askham Bros. & Wilson, Limited, of Sheffield, have recently issued a 46-page book illustrating and describing tramway junctions, cross-overs, &c, constructed by them for various corporations. They have laid out a portion of their works (5 acres), specially equipped for the construction of junctions, &c, complete, ready for laying on the road, which many tramway engineers agree is far better than doing this work on the site. The firm also manufacture all kinds of material for tramway permanent way, including points and crossings, patent drain rails, patent joint plates, platelayers' tools, &c.; and although they recommend the tongues and fittings for their points and crossings to be made of toughened cast-steel, where required they are supplying these in manganese steel.

The Electrical Company, Limited, have sent us a copy of their list No. 1A of dynamos and motors for continuous current. Much of the matter is in tabulated form, and some illustrations are given of large turbine and other types of generators.

The Knecht Brothers, Company, of Cincinnati, O., have sent us a small list of their friction sensitive drill press for variable speeds.

Messrs Mather & Platt, Limited of Manchester, have issued an illustrated catalogue, got up in their usual attractive style, in which a good deal of information is given about their improved high lift centrifugal pumps. Their chief features as compared with the reciprocating pump, are stated to be silent running and absence of wear and tear.

Messrs. Royce, Limited, of Manchester, have sent us some lists of their stock motors and generators.

Messrs. Turner & Hudson, Limited, of Ivy Street, Hoxton, N., are sending out revised prices of electric wire casings and covers.

An illustrated circular of continuous current electric motors has come to hand from Messrs. Millington, Everitt & Co., Limited, of Cambridge. The business was to have been disposed of by auction on Wednesday, but an advance offer for the concern was received as stated under "Liquidation" Notices.

Cooling Towers.—Mr. Arthur Koppel, of 27, Clement's Lane, E.C., has issued a new catalogue of his water and air-cooling towers on the Balcke system. We understand that he has erected, and has in course of erection, the following cooling towers for different corporation electricity works and electric companies:—Sheffield Corporation, fan tower, 180,000 gallons; Barnsley Corporation, fan tower, 80,000 gallons; Manchester Corporation, three fan towers, 270,000 gallons; Edmundson's Corporation, fan tower, 80,000 gallons; John Brown's, Sheffield, fan tower, 80,000 gallons; Charing Cross and City Electric Company, Limited, six natural draught towers, 450,000 gallons; Weston-super-Mare Electricity Works, natural draught tower, 75,000 gallons; Birkdale Electricity Works, natural draught tower, 45,000 gallons; Hampstead Electricity Works, natural draught tower, 80,000; Barking Electricity Works, open type cooler, 45,000 gallons; Bexhill Electricity Works, open type cooler, 20,000 gallons; Portman Market, London, open type cooler, 12,000 gallons. The catalogue before us is excellently illustrated by means of photographic and sectional views.

Core-Wire Straightener.—The Blake-Knowles patent Climax core-wire straightener is a new tool which has been patented by the Blake & Knowles Steam Pump Works, Limited, of Queen Victoria Street, E.C. This machine is of use for foundries where cores of considerable size are used. In almost every such plant may be found a large accumulation of bent and twisted wires or rods, from which the core makers select only such as may be easily straightened. The result is that requisitions are constantly being made for new rods while the stock of old ones keeps on growing. With the Climax straightener, the supply of core rods can always be kept in good order, and no time need be wasted by the core maker in handling a lot of material he cannot use. It is claimed that the cost of putting the old material into shape to be used again is so small that a great saving is effected and the machine will soon pay for itself. A machine of the size to straighten wires of $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, and $\frac{3}{4}$ in., requires about 4 or 5 H.P. to drive it, the pulley shaft running at 80 revs. per min. It may be run from a line of shafting, or belted, or geared, directly to an electric motor.

a line 2 miles 4 furlongs in length, commencing in Uxbridge Road

Bill.

A.B.P. Batteries.—Messrs. Ashmore, Benson, Pease and Co., Limited, of Stockton-on-Tees, have secured the following orders for storage batteries:—Talgarth Asylum, Breconshire (O'Gorman & Cozens-Hardy, consulting engineers); Saltburn electricity supply station; Sir William Ingram, Bart., Westgate-on-Sea.

British Fire Prevention Committee.—The executive announce that Mr. Ellis Marsland, district surveyor of Camberwell, has consented to act as honorary secretary. The working executive has also been strengthened by the following additional members, namely, Mr. J. W. Sheppard, North British and Mercantile Insurance Company; Mr. Langridge, A.M.Inst.E.E., Royal Insurance Company; and Mr Hamilton, A.R.I.B.A., district surveyor for North Fulham. As to the testing arrangements of the Committee for the coming session, tests are being arranged with another heavy warehouse floor, with roofing by the Vulcanite Company, Limited, and with glass by the Union Plate Glass Company, Limited, who wish to have their wired glass compared with the glazing of the Luxfer Prism Company and Messrs. Pilkington, whose materials have already been under investigation.

E.L.B.—Mr. O. T. Banks (O. T. Banks & Co., of Mortimer Street, W.) announces that since the issuance of his circular regarding electric lighting boards and strips, arrangements have been made by which he ceases to make or supply electric lighting boards, strips, lamps, or accessories described as being on the O.T.B. system. Any electric lighting boards, strips, lamps, or accessories henceforth sold by him in the ordinary retail way of business will be on the E.L.B. system, manufactured by the Electric Lighting Boards (British Manufacturing Company), Limited. Mr. Banks will continue to carry on his ordinary business as an electrician and fittings manufacturer at 49, Mortimer Street.

E.L.B. Employés and Vaccination.—The question of vaccination in factories is one of such great importance, and the prejudice generally against vaccination is apparently so great among mechanics and labourers, that the directors of Electric Lighting Boards (British Manufacturing Company), Limited, thought it advisable to allow every member of their staff 2s. 6d. as vaccination bonus money, and leave on full pay in the event of any member of the staff being unable to work owing to vaccination. Under these arrangements, the entire staff of the Electric Lighting Boards (British Manufacturing Company), Limited, factory, 80, York Road, King's Cross, some 100 hands in all, from the manager to the girls and smallest boys, were simultaneously vaccinated, and the directors thought that, owing to many difficulties in this direction, the example set might judiciously be followed in other factories.

Electric Lighting Department Abandoned.—At the annual meeting of Messrs. Shirras, Laing & Co., Limited, electrical engineers, &c., Aberdeen, the chairman moved the adoption of the report, and in doing so, stated that the electric lighting department having proved unremunerative, it was to be closed, but various improvements in the management would be carried out.

Electrical Trades Union.—A branch of the Electrical Trades Union was opened at Leicester on Friday last, at which over 40 members were enrolled. This is to be followed by a branch opening at the Devonshire Hotel, Barrow-in-Furness, on Monday, April 21st, and the week following at Preston, making the sixth additional branch opened this year.

Electricity in Railway Engineering Shops.—The new railway engineering works of the Union Pacific Company at Omalia, U.S.A., are to be electrically equipped throughout on the most modern principles. Direct coupled steam-driven generators of about 750 H.P. capacity are now being installed. It has been decided to split the driving power up into as small units as possible, the idea being to provide each machine tool with an independent motor for its driving and control. For this purpose over 20 motors, ranging in size from 5 H.P. to 25 H.P., are to be put in. A similar installation is also being put down in the workshops of the Oregon Short Line Railroad Company at Pocatello, Idaho, where generating plant of about 500 H P. and 12 motors of from 5 H.P. to 25 H P. are now being installed. The whole of the installation, including steam engines, generators and controlling devices, is of the well-known standard Westinghouse types. The various machines are all being supplied under strict guarantees by the contractors, and there can be no doubt that the railway companies will derive considerable benefit from their adoption of modern ways and means of engineering manufacture.

Exhibits.—At the Furniture Trades Exhibition at the Agricultural Hall, April 2nd to 12th, we noticed a nice selection of pedestals suitable for electric lighting and decorative purposes exhibited by Messrs. Chas. Marco & Co., 4, New Zealand Avenue, F.C, Mr. W. Höfler, 26A, Soho Square, showed specimens of hammered iron work and electric light fittings of tasteful design.

Fuel Economisers.—What is probably the largest order ever placed for economisers has been secured by the well-known makers and patentees of this apparatus, Messrs. E. Green & Son, Limited, of Manchester and Wakefield. The installation, when complete, will contain about 10,000 tubes, representing some 100,000 sq. ft. of heating surface, and is for the new generating station to be erected by the syndicate who are electrifying the system of the Metropolitan and District Railways. Messrs. Green and Son, Limited, we are informed, have also secured several other important orders for electrical undertakings—viz., the Manchester Corporation Stuart Street generating station (nearly 3,000 tubes), and also for Brussels and Berlin electric tramways.

At the Light Railways and Tramways Exhibition, at the Agricultural Hall this summer, Messrs. Green will exhibit an economiser of 96 tubes, with the usual blow-off and safety valves and patent access branch pipes at the bottom; these latter are to facilitate the easy cleaning out of the bottom boxes. The top boxes will be fitted with internal lids, and the economiser will be constructed for a working boiler pressure of 160 lbs. The scraper motion will be driven by a motor. They will also exhibit a small 5-in. horizontal high-speed engine for driving the scraper gearing where an electric motor is not available.

Hart Traction Batteries.—The Hart Accumulator Company, Limited, of Stratford, are now placing on the market an entirely new form of cell for traction work, and they have issued a new list showing full particulars and prices. They have experimented very largely during recent years with cells for motor cars, the outcome being that the cell they are now supplying is specially suitable for such work. Lightness and cheapness are claimed as special features.

Meeting of Creditors.—A meeting of the creditors of Lewis Bayliss, of Wednesbury, was held on Friday last week at the office of the Official Receiver (Mr. Sam Wells Page), Lichfield Street, Wolverhampton. A statement of the debtor's affairs appeared in the last issue of the Electrical Review. The meeting was of a purely formal character. It was resolved that Mr. W. R. Davies, chartered accountant, Birmingham, should act as trustee of the debtor's estate on behalf of the creditors at a remuneration to be afterwards determined upon, and the following gentlemen were appointed a committee of inspection:—Messrs. E. F. Cordwell, London; Titley (Cable Company, Birmingham); and Foster (Gaskill & Groucutt, Birmingham).

New Arc Lamp.—The Knewe Arc Lamp Company, of 232, Hornsey Road, Holloway, N., is placing the Knewe enclosed arc lamp on the market. Among the important advantages claimed for it are:—It is a "single enclosure" lamp, and although the life of the carbons is somewhat shortened by this method, a maximum of light is thereby obtained. With some lamps employing an inner globe, a serious loss of light is noticeable after a few hours' burning, due to the deposit on this inner globe, but it is claimed that there is practically no deposit in the Knewe lamp. The globe has not to be removed for trimming, thus reducing the bill for globe breakage. The trimming is very simple, and is easily performed. The lamp is only 20 in. in length, and is considered very neat, and is claimed to burn absolutely steadily.

Proposed New Works.—The *Leeds Mercury* says:—"An Austrian firm of electrical engineers are seeking to establish works in this country; and Huddersfield having been mentioned as one of three towns selected, a meeting of local moneyed men has been held, with the purpose of taking steps to float a company."

Reduction of Capital.—The petition for the reduction of capital of the Chloride Electrical Storage Syndicate to £135,250 came before the Vice-Chancellor at the Chancery Court of Lancashire the other day, and the order was granted.

Schmidt Superheating.—Messrs. Easton & Co. have received an order from Messrs. Belliss & Morcom, Limited, of Birmingham, for one of the Schmidt patent direct fired superheaters, which we understand they propose to make use of for testing purposes in their works.

Swinton and District Workshops Cup Competition.—In the first round of the above competition, the Chloride Electrical Storage Syndicate Football Club beat the General Electric Football Club by the substantial margin of 16 points to nothing.

Trade Announcements.—Messrs. Nalder Bros. & Co. are removing their offices and showrooms to larger and more convenient premises at 12, Carteret Street, Queen Anne's Gate, Westminster. All communications should be addressed there.

The firm of Mr. H. Hodgson Wright will in future be known as Messrs. Hodgson Wright & Wood, and the business of electrical engineers will be continued at North Parade, Halifax.

Messrs. Everett, Edgcumbe & Co. notify that owing to the extension of their business, they are removing to larger premises at 151—153, Great Saffron Hill, Holborn Viaduct, E.C., to which address all communications should be sent.

Messrs. C. A. Parsons & Co., of Newcastle-on-Tyne, have recently opened offices at 99, Great Clyde Street, Glasgow, and have appointed Mr. A. A. W. Wynne, M.A., to represent them in Scotland, for their steam turbines for driving dynamos, alternators, pumps, compressors, &c. We have received a copy of the firm's latest catalogue, in which many illustrations appear of the works, and of electricity supply stations in which the Parsons turbine is doing service. A full description of the engine is given.

Messrs. W. F. Dixon & Co. have just added an extension to their premises at C.-on-M., Manchester, where they carry on the manufacture of raw-hide gears and electrical accessories. A special feature is made of electrical insulating work for tramway and railway carriages, gas and oil engines, &c. The works are equipped with the most modern tools and special appliances for the manufacture of spur, bevel, worm, and friction wheels.

Wheeler Cooling Towers.—The Wheeler Condenser and Engineering Company have received the contract to supply three sets of cooling towers for the Stuart Street Station, Manchester, the plant to be capable of dealing with 300,000 gallons of water per hour. They have also in hand at the present time a cooling tower and condensing plant for the Lister Drive Station at Liverpool of a capacity to deal with 42,000 lbs. of steam

per hour, the outfit consisting of the fanless flue type of cooling tower. A duplicate plant of the same capacity is in hand also for the Carlton Iron Works. Among other plants in progress is a fan type cooling tower plant for the Staveley Coal and Iron Company, Warsop Colliery, this consisting of fan-driven cooling tower with surface condenser and centrifugal pumps. The plant has a capacity to deal with 40,000 lbs. of steam per hour. The order for the extensions at the London United Tramways, Chiswick, consists of cooling tower with condensing plant to deal with 30,000 lbs. of steam, and also a cooling tower and condensing plant for the Lowestoft Electric Light Station. An order has been received for cooling tower and condensing plant for power station at Helsingfors, in Russia. Among the many condensing plants on order are five large sets for the Great Northern Railway power station, a set for the Erith electric light station, and one for the Blackheath and Greenwich electric light station. A large plant is also on order for the Electrolytic Alkali Company, of Middlewich, as well as a number of plants in hand for refrigerating stations.

ELECTRIC LIGHT AND POWER NOTES.

Austria.—Plans have been prepared for the establishment of a large plant at Tazen to utilise the water power of the River Save in the generation of electrical energy for lighting and power purposes at Laibach.

Barnes.—The appeal against the assessment of the electric lighting works has been settled at £200 for the current 12 months, and £400 subsequently. The agreement can be set aside if the U.D.C. should decide to supply power for traction purposes.

Barnsley.—During the past year the plant has been considerably extended, and £9,748 has been spent on machinery. The number of consumers has increased from 209 to 280, the number of arc lamps from 15 to 27, and 41 motors of 191 H.P. are now in use. The lamp connection has also very largely increased—from an equivalent of 14,825 8-C.P. to 22,183 8-C.P. lamps. The total receipts from the sale of energy amounted to £4,460 14s. 9d., and from fittings £149 6s. 1d., and the year's profit amounted to £2,543 4s. 3d., an increase of £292 8s. 9d. over last year. Bringing forward the balance from last year, £8 1s. 10d., and setting aside £2,397 0s. 5d. for interest and redemption, there remains a balance amounting to £154 5s. 8d., which is to be carried forward. The Committee has unanimously agreed to reduce the flat rate charge from 4½d. to 4d.

Basingstoke.—The T.C. has resolved to apply to the B. of T. for an extension of time for the electric lighting order, which expires in June next.

Bath.—Application has been made to the L.G.B. for permission to borrow £25,000 in respect of the proposed alterations and extensions. Mr. Teague is preparing plans and maps, and the City Council has resolved to call Mr. Manville as a witness. The thanks of the Committee were tendered to Mr. Teague and his staff for the efficient services rendered by them, and it was resolved that a gratuity of £52 10s. be granted to Mr. Teague, and that the Council be recommended to grant a fee of £105 for the ensuing year, for services to be rendered by him in carrying out the proposed extensions. The staff also received gratuities.

Bristol.—At the Bristol City Council meeting on Tuesday, Alderman Pearson, the chairman of the Electrical Committee, explained what the Committee intends to do to meet the growing demand for electricity for power purposes. The Temple Back station has for some time been packed with machinery for the lighting load, and several of the alternators are of small size, and occupy much space in proportion to the kilowatt capacity. The intention is to gradually make the new station at Avonbank, on the outskirts of the city, the lighting station, there being there unlimited room for expansion. The present change is the first step in this direction. Three alternators, two of 88 KW. capacity each, and the other of 210 KW., will be displaced, and room made for two 500-KW. turbo-dynamos. The installation of one of these costing £6,300, the Council authorised on Tuesday; and Alderman Pearson said if the power load went on increasing as it was now doing, he should shortly have to come for sanction for a second turbo-dynamo. Of the three displaced alternators, one will be transferred to Avonbank, and the two small ones disposed of, the loss being written off the revenue account of the works. A fourth alternator of 210 KW. will be turned from lighting to power purposes. The result of the changes will be that the present power capacity will be increased from 480 KW. to 1,190 KW., or a margin of 250 KW. over the demands actual and in sight.

The Electrical Committee have entered into a contract for the supply of coal to the Temple Back works for the year ending March 25th, 1903, at 11s. 10d. per ton.

Bulawayo.—The new engine equipment of the electric lighting works has been supplied by Messrs. Robey & Co., Limited.

Carlisle.—The Electricity Committee of the Corporation has decided to make application to the L.G.B. for sanction to borrow the sum of £24,000, the cost of the electric lighting extensions and plant for traction purposes.

Cheltenham.—There are at present 570 consumers of electric light, with the equivalent of 35,760 8-C.P. lamps connected. The T.C. has resolved to give the preliminary notices with a view to making application to the B. of T. for an amendment of the Electric Lighting Order by extending the area of supply to comprise the parishes of Prestbury, Bishop's Cleeve, Leckhampton, Swindon, Southam, Woodmancote, and Brockhampton.

Chesterfield.—An electrical exhibition arranged by the Corporation was opened on Wednesday, 16th inst., by the Mayor. It will remain open until 24th inst. Mr. R. L. Acland has acted as organising manager.

Dartmouth.—The Electric Lighting Company's plans have received the approval of the T.C., and the generating station will be erected at Sandquay as soon as possible.

Edmonton.—The U.D.C. has received a deputation from the Ratepayers' Association protesting against any expenditure upon electricity supply without the sanction of the ratepayers.

Elland.—The D.C. has received the sanction of the L.G.B. to a loan of £16,000 for the electric lighting and refuse destructor scheme.

Glasgow.—The following arrangement, though not officially sanctioned, may be taken as approximately correct. Negotiations between the tramways and lighting departments are still in progress, but the proposal at present is for the latter to take current from the former during the afternoons in winter, ranging from ½ to 2½ hours. The tramways department have something like 5,000 H.P. still to utilise, and it is thought that it will be fully 10 years before this power will be required for extensions. The lighting department have considerable additions to plant to make to meet next winter's estimated demand; hence the negotiations. The maximum and minimum demands it is proposed to fix at 1,800 and 1,500 KW. respectively. The power will be transferred from Coplawhill sub-station of the tramways, to the St. Andrew's Cross station of the lighting department, the current from the main generating station at Pinkston being transformed from 6,500 to 350 volts alternating through transformers, and from 350 volts alternating to 550—600 volts direct through Westinghouse rotary converters. The demand proposed to be taken is 150,000 B. of T. units per annum, the charge being 1½d per unit plus 5 per cent. on capital outlay expended for the purposes of transference of power, this being estimated at about £1,800. The annual payment is estimated at £1,023, and if the energy realises an average price of 4d. per unit, or even 3½d. the flat rate, the net profit to the lighting department amounts to over £20,000. The proposed agreement is for three years. Tenders for the necessary plant are to be advertised for.

Greetland.—The L.G.B. has sanctioned the application of the Council for power to borrow £16,000 for the purpose of providing an electrical installation and refuse destructor.

Hendon.—The result of the recent D.C. election was the victory, by an overwhelming majority, of the two candidates who are opposed to the Council carrying out electric lighting in the district at present. Great interest in the election was evinced, and the poll was one of the heaviest cast for years.

The D.C., at a recent meeting, decided to have a poll of the parish at an early date on the subject, but whether they will carry out the decision now seems somewhat doubtful.

Kimberley.—A public meeting of townspeople has authorised the Borough Council to borrow £10,000 under the Local Works Loan for the extension of the electric lighting system, with a proviso that no portion of the amount is to be expended upon any new generating plant otherwise than that already under order, until after consultation with the De Beers Company directors, unless it be found that the De Beers Company cannot deliver energy to the Council at a lower rate than the Council can produce it at. The explanation of this is that the De Beers Company are now erecting a central power station, probably the finest of its kind in South Africa, and negotiations are proceeding with a view to the Council taking a supply of energy from De Beers if it be found more advantageous to do so.

Lincolnshire.—A combined electric lighting and pumping plant has just been installed at the Trent Iron Works. According to the *Sheffield Independent*, the motors, coupled direct to centrifugal pumps, are distant from the works 1 mile and 1½ miles respectively, and are capable of pumping 600 and 300 gallons per minute, lifting the water 30 ft. from the mines into the drain. They can be controlled from the works, and, being self-oiling, will run night and day when required. The power is generated by the surplus gas from the blast furnaces. All the iron smelting firms in North Lincolnshire have now adopted electric lighting throughout their works, and for some time a good deal of the heavy machinery at the steel works has been propelled by electrical energy.

Long Eaton.—The D.C. last week considered the tenders for the electric installation.

Lowestoft.—The T.C. has decided to adopt the following prices for energy for power purposes:—2½d. per unit up to 1,000 units, 2d. per unit up to 2,000 units, and 1½d. per unit 2,000 to 5,000 units per annum.

Lynn.—The T.C. is arranging to afford a supply of electricity for street and private lighting within the parish of Gaywood at the same terms as those charged within the borough, provided a sufficient revenue be obtained.

Kilmarnock.—It is reported that Mr. Bryson, electrical engineer, has put in a claim against the Corporation for the payment of £976 17s. 3d. Mr. Bryson was consulting engineer to the Corporation in connection with the proposed electric installation, but the scheme was abandoned, and the question taken up *de novo*.

Manchester.—The Electricity Committee is now in a very favourable position for supplying energy, and is prepared to receive applications in connection with the Coronation festivities.

Natal.—The Natal Government Railway Department has been advised to put down polyphase plant in the new electric station.

A report has been presented to the Maritzburg Town Council on the subject of an expert being employed for the purpose of reporting upon the existing electric light system. The report states that "in selecting an expert it must be borne in mind that he must be a disciple of the alternating current system of electric lighting." The report also recommends that the estimates, &c., for the extension work be sent to England for the purpose of being checked.

New Zealand.—*Australasian Hardware and Machinery* says that it is intended to invite Lieut.-Colonel Turretini, of Italy, who has had practical experience of such work since 1882, to visit New Zealand and report on the adaptability of any of the rivers or lades of Canterbury for generating electricity. If the expert is unable to come himself, he will be asked to suggest a member of his staff.

The same journal says that the North Mount Lyell Mining and Railway Company are erecting an electric light and motive power plant at Crotty, on the West Coast of Tasmania. Mr. J. H. Newby, an engineer from Cincinnati, is in charge of the works.

Newcastle.—The Finance Committee of the City Council is negotiating with the Tramways Committee for the supply of electricity for the electric lighting of the municipal offices, &c.

Partick.—The Burgh Commissioners have decided to extend the public lighting in the burgh by adding 25 arc lamps. Tenders will be invited shortly by public advertisement.

Romford.—The U.D.C. is applying to the B. of T. to extend the prov. order for electric lighting for a further period of two years.

Russia.—At the commencement of the present year the central station of the Société d'Eclairage Electrique de St. Petersburg was supplying current to an equivalent of 222,741 10-c.p. lamps, as compared with 183,790 lamps at the beginning of 1901. The plant has now a capacity of 8,000 H.P.

Sheffield.—At a meeting of the T.C. last week, Ald. Styring referred to the death of a man at the Theatre Royal, and stated that whatever was the cause of death, it was not an electric shock.

Southampton.—Mr. H. F. Street has further reported to the T.C., urging the necessity of taking immediate steps to prepare the site of the new generating station, so as to prevent delay in meeting the increased demand next winter.

Stockton.—The T.C. has received the sanction of the L.G.B. to borrow the sum of £26,730 for electric light purposes, £21,000 being in respect of new works.

Sunderland.—Mr. J. F. C. Snell, electrical engineer to the Corporation, has been authorised to visit Berlin and some English towns, to report on the distribution of electrical energy on the three-phase system.

Sutton.—The Surrey Electric Power Distribution Company's generating station was ceremoniously opened last Saturday week, in the presence of a large gathering. The plant, &c., was briefly described in these columns on March 28th last.

West Bromwich.—Mr. G. H. Tulloch, L.G.B. inspector, held an inquiry at West Bromwich last week, in reference to an application by the Corporation for sanction to borrow £10,000 for the purpose of defraying the cost of certain extensions, improvements, and new machinery necessary in connection with the borough electricity works.

West Hartlepool.—The gross profit on the electric lighting concern during the past year was £1,238. Against this had to be set interest and redemption of loans amounting to £2,510, leaving a net deficit of £1,272.

ELECTRIC TRACTION NOTES.

Ayr.—The Town Council, by a vote of nine against eight, have decided to take a poll on the question of Sunday cars—whether they should be continued or not. It may be mentioned that the receipts on Sundays are about double those of an average week day.

Baltimore and Ohio Railroad.—The Baltimore and Ohio Railroad Company, on March 25th, put into active service the third-rail system installed on the belt line between Camden station and Waverley through its tunnels under Baltimore. Final tests were made and one of the electric locomotives was regularly using the third rail. The other two locomotives will follow suit as soon as they are equipped for the purpose. Baltimore and Ohio engineers regard the system as a complete success, and the entire overhead electric conductors and supports will be torn down. The belt line has been fenced in for its entire length where the third rail is used, to keep persons from walking on the tracks. The third rail is charged over the whole route to Waverley, except at Camden and Mount Royal stations. In Baltimore the device used keeps the third rail "dead" until it is automatically cut in by the electric locomotive in passing over the surface. It is cut out by the same method. The remainder of the third rail is protected by wooden guards. The system will prevent smoke and gases in the tunnel.—New York *Electricity*.

Clydebank.—At the meeting of Commissioners on 14th inst. the Provost intimated that negotiations were still proceeding with the Corporation of Glasgow regarding the extension of the latter's tramway system to and through the burgh of Clydebank.

Croydon.—The *Times* says that on account of the Budget debate the Croydon and District Electric Tramways Bill, which was down for second reading "by order" at the time of private business, will be postponed until Monday next. Notices of motion for the rejection of the measure have been handed in by Mr. H. W. Forster and Mr. Vicary Gibbs.

Crystal Palace.—On 10th inst. the Light Railways Commissioners heard opposition to the application of the Crystal Palace Light Railways and Tramways Company to construct a light railway (2½ miles) from Camberwell to the Crystal Palace, and in the end the application was withdrawn.

Deal.—In connection with the projected light railway between Deal and Sandwich, there is a proposal to include Walmer also. The Kent Electric Power Syndicate have offered to submit a comprehensive scheme, and, if desired, they are to undertake the working of the line. The question is being considered by the three Councils.

Dover.—The Corporation last week decided to oppose the projected electric light railways from Dover into the country.

Eastbourne.—The Town Council last week had a long debate on the introduction of trams, the subject being brought before them by a recommendation of the Electric Light Committee that an application should be made to the Light Railway Commissioners for an order authorising the Council to construct and work tramways from the east end into the centre of the town. The Committee had previously discussed an alternative scheme, which included a branch line to the Railway Station, estimated to cost £29,925. The scheme which the Committee recommended the Council to adopt was the shorter one, the length of which would be only 1 mile and 250 yards, and this with a single track. The engineer estimated the cost as follows:—

Single track, Archery Hotel to Post Office	£9,500
Ditto to the car sheds	1,875
Four cars	2,600
Car house, &c.	2,500
Four passing places	600
Feeder cables, steam dynamos, switchboard and connections	3,450
Total	£20,525

It was suggested that the cars should run every 10 minutes between the hours of 6 a.m. and 11 p.m. The estimated cost of running, inclusive of interest and sinking fund, was 9d. per car-mile. This would necessitate carrying at least nine passengers in each car over the whole line to make the scheme pay. There has been a great demand by the working-class population of the east end for a cheap and rapid means of transit into the centre of the town, but strenuous opposition has been raised by the people in other neighbourhoods, who contend that the introduction of trams would drive away carriage visitors. The advocates of the scheme urged the extension of trams to the other extremities of the town; but, after considerable discussion, it was resolved, by 18 votes to 9, to defer the whole question until the Electric Light Committee had reported upon a scheme for running a motor 'bus service, powers for which are sought in the Corporation Bill now before Parliament.

Glasgow.—The last horse car disappeared from this system last week, the Shettleston—Tollcross section having been now completed for electric cars.

Hampton Wick.—The L.U.T. track between the foot of the bridge and Hampton Court was commenced last week. A very large number of men are at work upon it, and the 1½ miles will probably be finished within a month. No steps have yet been taken to widen Kingston Bridge.

Jarrow.—The B.E.T. Co. intend shortly to commence the construction of the light railway through the borough.

Johannesburg.—A deadlock has been reached regarding the re-starting of the tramways. The Town Council are determined to get control of the system, but the company will not enter into negotiations with them. In the new powers which are sought by the Council, they apply for the sole right to construct electric tramways.

Johnstone, Renfrewshire.—A letter from Mr. Murphy, the promoter of the Paisley District Tramways Company, was read at the Council meeting on 14th inst., intimating that his plans and arrangements were now almost complete for approval by the local authorities.

Liverpool.—From the capital account of the Corporation tramways to December 31st, 1901, it appears that the net expenditure on the acquisition of properties, reconstructing track and constructing new track, cost of rolling-stock and other stock, and of works and charges in connection with the establishment of the electric tramways, had been £1,749,428 9s. up to December 31st last. The heaviest item of the outlay has been the purchase money paid to the Liverpool United Tramways and Omnibus Company for their property, which was £567,375. On tramway lines, £257,821 10s. 4d. had been paid up to the end of last year, and on reconstruction and extensions, £561,586 11s. 3d. Land and buildings cost £102,659 14s. 7d. Cars cost £250,943 15s. 10d. The stamp duty on the conveyance of the old tramways undertaking to the Corporation required £2,837. The expenses incurred in the promotion of the tramways provisional order amounted to £2,224 19s. 9d. Engineers' fees amounted to £2,967 6s. only.

London to Dover.—The *Yorkshire Daily Post* reports that two alternative routes are being surveyed in Kent for the purpose of a double line of electric railway between London and Dover, for which it is proposed to ask for powers in the next Session of Parliament. One route is *viâ* Maidstone and the other *viâ* Chatham.

London Underground Schemes.—The daily press has been publishing a good deal this week about Mr. Yerkes' new company—the Underground Electric Railways Company of London, formed with a capital of £5,000,000. The objects of the company are stated as follows:—For the purpose of electrifying the District Railway, and building and working by electricity the following lines:—(1) The Brompton and Piccadilly Railway. (2) The Great Northern and Strand Railway. (3) The Charing Cross, Euston and Hampstead Railway. (4) The Baker Street and Waterloo Railway. The mode of construction proposed and the character of the work generally is to be similar to that adopted on the Central London Railway. The lines will be double throughout, each road being carried in a separate tunnel, lined with cast-iron. These tunnels will be constructed for the greater part of their length through London clay, and will be driven in the ordinary way by means of the "Greathead" shield, and at such depths as to avoid interference with the sewers, gas, or water mains. At the stations there will be platforms 300 ft. in length and 11 ft. in width. Lifts and stairways will also be provided. Facilities are to be given for the interchange of traffic where the lines cross each other and where they are adjacent to existing railways. A central power station is proposed to be constructed in Lot's Road, Chelsea, with access from rail and river, where high-pressure, three-phase, alternating current will be generated and transmitted by cables to 20 sub-stations. At these sub-stations the alternating current will be converted into direct current at 500 volts, in accordance with the requirements of the Board of Trade. It is proposed that the trains shall consist of seven carriages (two of which will be motor cars), each measuring 50 ft. over all, and each seating 48 persons.

Metropolitan District.—In the London Sheriffs' Court on 11th inst., before Mr. Under-Sheriff Burchell and a special jury, Mr. Wall, a building contractor, of Chelsea Creek, set up a claim for compensation from the Metropolitan and District Railway in respect of the removal of his works in Chelsea Street, Fulham, on the site of which the railway proposed to erect their generating station for the electrification of the line. Sir Edward Clarke stated that some extraordinarily large amounts of money were involved. The claim was in respect of the reinstatement of Mr. Wall in business from the north side of the river to the south side. He had to give possession in a fortnight, and if there was six months' delay in his work he would be mulcted in his present contracts in penalties amounting to £25,000. Mr. Green, of Chancery Lane, assessed the proper amount of compensation at £70,387. The inquiry was adjourned.

Middleton.—The opening of the new electricity works of the Middleton Corporation, near Manchester, which was followed by the opening of the Middleton Electric Traction Company's tramways, took place on Monday last. A large company assembled outside the works, and the engineers (Messrs. Lacey, Clirehugh & Sillar) presented to Alderman Walker, chairman of the Electricity Committee, a gold key, with which he opened the doors. The works are situated in the centre of the town, adjacent to the gas works and municipal buildings, and are, therefore, extremely convenient for the officials and all concerned. The equipment comprises three engines direct coupled to dynamos capable of supplying all the power required by the Electric Traction Co., as well as an additional three miles, which will shortly be completed in the direction of Manchester. So far, there have been 30 applicants for illumination, and this department is also regarded as satisfactory. The engines were started, and afterwards the party were conveyed over the system of eight miles at present open, returning to the Town Hall for luncheon. Councillor J. J. Schofield, Mayor of Middleton, presided, and after the usual loyal toasts, Mr. J. S. Raworth, M.I.C.E., director of the British Electric Traction Company, Limited, proposed "The Corporation of Middleton," and congratulated the town on the inauguration of the enterprise, remarking that local travelling would ultimately become as cheap as main line travelling, and there would soon be a magnificent tramway system throughout Lancashire. It behoved them to consider the question as to who should work them, or whether they should be allowed to get into the hands of one great Corporation, Manchester, for instance.—County Councillor Aspell proposed the toast of "The Middleton Electric Traction Company, Limited," which, he said, was the very latest of the numerous progeny of the British Electric Traction Company. The Corporation and the public of Middleton wished them every success.—Mr. Raworth responded, and Mr. Price, of the British Electric Traction Company, also replied in the unavoidable absence of Mr. Stephen Sellon, their chief engineer. The trams, which were gaily decorated with flags, &c., continued to run throughout the day, and were well patronised by the public.

Moville.—As already intimated, the preliminaries for approaching the Irish Privy Council for authority to construct an electric tramway connecting the port of Derry with Moville have been arranged. The scheme has been in hand for some time. So far back as August last Mr. Wyndham, the Irish Chief Secretary, was approached on the matter by a deputation, but nothing came of it. Some London financiers and gentlemen interested in railway construction subsequently took the matter up, with the result that they have decided to construct the line. The system to be adopted if the scheme have a successful issue, is the overhead trolley. The line will run from Derry *viâ* Culmore, and partly by road. It is proposed to generate electricity by turbines driven by Cabry River, Onigley's Point. Moville is the embarking and landing place for the Anchor and Allan Steamship Lines.

Newcastle-on-Tyne.—The electric tramways are making headway, as was shown by the figures Mr. W. Cail, the chairman of the Committee, submitted at the Council meeting on the 9th inst. The report stated that during the four weeks ended March 29th there had been 70 cars in use and 158,000 miles had been run, the receipts amounting to £7,836, or an average of 11·9d. per car-mile. The cars had carried 1,757,373 passengers, or seven and a half times the population of the city. Sir Chas. Hamond thought the time had arrived for the Committee to give a statement of the expenses incurred for working, wages, &c. Mr. Cail said he would rather Sir Charles brought the matter up in the form of a motion, a course which Sir Charles said he would adopt. On a motion by Mr. Frederick Heald it was decided that the Finance Committee should be recommended to negotiate with the Tramway Committee for terms for the supply of electrical energy and lighting to the various properties of the Corporation.

Newport (Mon.).—At the County Council meeting last week, the direct labour question in connection with reconstructing and altering the tramways for electrical traction was discussed. The Electricity and Tramways Committee being equally divided as to the question of contract *versus* direct labour, left the matter for the Council to decide. It was resolved to invite tenders for the work.

Oldbury and Blackheath.—The Oldbury U.D.C., on Friday last, considered correspondence with the Birmingham and Midland Tramway Company respecting the tramways to be constructed between Oldbury and Blackheath and Langley, and gave its consent to the scheme. The clerk (Mr. W. Shakespeare) explained that since the last meeting of the Council he had had a great deal of correspondence with the solicitors of the company, who at first suggested that the Council should contribute something towards the cost of widening Halesowen Street, but he replied that this proposal could not be entertained. The company now proposed to widen the respective streets, including Halesowen Street, upon condition that the Council extended the period of the lease, after which they would have the right to purchase the existing or any new tramways that might be constructed to Oldbury, in from 21 to 35 years. They required a clause to be inserted in the Bill to this effect. It was pointed out that the widening of Halesowen Street would cost from £19,000 to £20,000.

Renfrew.—The agreement between this burgh and the Corporation of Glasgow is now ready for signature, and the extension of the tramway system to Renfrew is to be proceeded with.

Sweden.—The Falun-Vesterdalen Railway Company have approached the Swedish Government with regard to a subsidy of 100,000 kroners to enable them to make some experiments with electric traction on their line, with the view of its eventual general adoption. The demand for the subsidy is based on the statement that the experiments would be of service to the State Railway authorities in connection with their talked-of scheme of adopting electric in place of steam traction. If the trials are taken in hand by the Falun-Vesterdalen Railway Company, water power will be utilised.

Tooting.—The transformation of the L.C.C. tramways to electric traction has been commenced at this end of the Tooting—Westminster line by Messrs. J. G. White & Co. Ample arrangements are made to avoid interfering with the existing service.

Twickenham.—Difficulty has been found in Heath Road in laying the L.U.T. track by the nearness of water mains to the road surface. The U.D.C. has agreed to the level being raised on the company arranging with the occupiers affected by the operation. No less than 33 owners have petitioned the Council against the alteration.

Wolverhampton.—Our local correspondent writes as follows:—"During the past fortnight very considerable progress has been made with the reconstruction of the tramway. The men are now busy on the Tettenhall Road, and very soon a junction will be formed with the lines on the Newhampton Road. The Lorain Company, too, is showing more activity. A large number of contact boxes have arrived from America, and several hundred of these have been placed in position. At the Council meeting on Monday the chairman of the Tramways Committee stated his confident belief that the trams would be ready for the opening of the Exhibition on May 1st, that is, provided, of course, the Government

inspector gives the necessary permit to run. Great indignation is expressed on all hands that in order to place the contact boxes in position it is necessary to take up almost a third of the track, thus involving a serious waste of material and time. The article on the Lorain system which appeared in the Electrical Review a fortnight ago was quoted *in extenso* in the *Express and Star*, and there have been many expressions of regret that such an able criticism of the Corporation's scheme had not appeared earlier, because it might have caused some of the local legislators to pause. Deputations from the Leicester and Warwick Corporations have within the past fortnight visited Wolverhampton and inspected the surface contact system."

TELEGRAPH AND TELEPHONE NOTES

New Telegraph Cables to the Malay Archipelago.—The *Times* published the following notes from "A Correspondent" on April 3rd:—"In July, 1901, a telegraph convention was signed between Germany and Holland, the importance of which transpired only recently, when the Dutch Government laid a Bill, embodying its main provisions, before the States-General at the Hague for their approval. The details of this joint scheme are very elaborate. In substance, however, it furnishes the two signatory Powers with the requisite authority to establish a new telegraphic communication between Germany and Holland, on the one hand, and their Asiatic possessions on the other, by means of cables, which shall be under the joint control of the two Powers and independent of the British cable companies concerned. It is proposed to accomplish this end by the formation of a German-Dutch cable company, the seat of which will probably be at Cologne. This cable company is to obtain the exclusive concession for laying telegraph cables from Menado, the chief place of Northern Celebes, to the island of Guam, belonging to the group of the Marianas, now in the possession of Germany, and from Guam to Shanghai. At Guam these cables will connect with the American Pacific cable between San Francisco and the Philippines. The Dutch Government having undertaken to lay a cable between Menado and Balik Papan, in Borneo, where a telegraphic communication already exists with Java, the result of the whole scheme, when completed, will be the establishment of an independent German-Dutch cable communication with the colonies of the two States in Asia, and with China, by way of San Francisco. The German-Dutch Cable Company, to be formed at Cologne, with articles of association to be approved by the Governments of the two States, will receive during a period of (at most) 20 years an annual subsidy which, in the case of Germany, will amount to about £50,000, and in the case of the Netherlands to about £14,000. But up to 90 per cent of the receipts of the company will be used for the purpose of reducing the annual subventions. The joint control of the two Powers will be exercised by an international directorate, one quarter of the directors being German subjects, and as many again Dutch subjects. Of the two managing directors, one must be a German, the other a Netherlander. The two Governments will, moreover, be represented on the board of the cable company by an official commissary. The convention, as far as its contents are known, contains an important proviso. In case of disputes concerning its interpretation, the signatory Powers agree to invoke, and abide by, the decision of the International Court of Arbitration at the Hague. But to the text of the treaty itself there is added a protocol, the contents of which are secret, and which protocol has, therefore, not been laid before the States-General. This has provoked some adverse criticism in the Dutch Press, which points out that such arrangements conflict with Article 59 of the Dutch Constitution, providing that all treaties whereby a cession of territory or an imposition of financial burdens is contemplated must be laid before the Legislature in full. And, naturally enough, a deal of speculation has been set afoot as to what the secret protocol may or may not contain, and in how far the convention itself may be affected by it. It is considered very likely that the contents of the said protocol are of a political nature, and deal with the dangers arising out of a state of war at some future date, against which the contracting Powers may want to arm themselves beforehand as much as possible. The treaty itself does not profess to contemplate a state of war. By it the contracting Powers aim at safeguarding an independent cable communication with their colonies in times of peace. But how could the same independence be maintained in a state of war? It will be remembered that, when the international conference for the protection of submarine cables met in Paris 20 years ago, the British Commissioners declared that they could not sign the convention then drafted unless the Powers represented at the conference agreed to the principle that belligerents would be left free to act when involved in war. The said Powers did so agree, and the treaty of March, 1884, contains a proviso to the effect desired by England at that time. How the Americans acted in the Philippines during their war with Spain is well known; and it is taken for granted on the Continent that, if England became involved in a European war, she would no more respect the neutrality of submarine cables belonging to belligerents than the Americans did at Manila. In the interests of international commerce such neutrality of cables would be, no doubt, highly desirable. The time may come when the advocates of neutral submarine cables will be able to carry their point; but obviously the German and Dutch Governments are of the opinion that the prospects of immediate reform in this direction are not very bright at the present moment; and hence their secret protocol above referred to."

The Pacific Cable.—Reuter reported on 9th inst. that the Pacific cable had reached Fiji.

The Telegraph Wire Export Trade.—March proved to be one of the quietest months, as regards the exports of telegraph wire and apparatus connected therewith from this country, that has been experienced for a long time past. The shipments during the month only attained a value of £36,746, which compares with £126,330 in February last and £106,638 in March, 1901. For the first quarter of the current year, too, the exports show a decline, having only amounted to £749,355 as contrasted with £829,270 in the corresponding three months of last year.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Alexandria-Larnaca	Jan. 19, 1902	
Assab-Massowah	March 17, 1902	
Perim-Obock	Feb. 26, 1902	April 10.
Cayenne-Pinheiro	March 8, 1902	April 10.
Colon-Jamaica	March 13, 1902	April 10.
Zanzibar-Mombassa	March 13, 1902	
Suakin-Djedda	April 16, 1902	
Landlines :—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900	
Communication with Baranquilla and Cartagena	Dec. 8, 1900	
Guanta-Barcelona	March 17, 1902	
Berlin-Versovic	March 31, 1902	
Barcelona-Ciudad Bolivar	March 6, 1902	

Wireless Telegraphy.—In the House of Commons Mr. Norman asked the Secretary to the Admiralty whether he would state what total amount had been paid for the use of the Marconi system of wireless telegraphy and the purchase of instruments, upon how many ships this system was installed, upon how many ships it was now in use, and upon how many ships a different system of wireless telegraphy was in use.

Mr. Arnold-Foster, in reply, said that no public purpose would be served by supplying the details.

In the Commons on 11th inst. also on behalf of Mr. Norman, the Secretary to the Treasury, as representing the Postmaster-General, was asked whether he would state what total sum had been expended by the Post Office in connection with wireless telegraphy, whether for purchases, for experiments, or for payments to individuals.

Mr. Austen Chamberlain, in reply, said that experiments in connection with wireless telegraphy had extended over a number of years, and the Postmaster-General feared that it would not be possible for him to furnish the information desired by the hon. member without considerable expense, which would scarcely be justified by the results. Such expenditure as has been incurred has been charged partly to the Vote for the Board of Trade and partly to the Post Office Vote for Telegraphs.

The New York *Herald's* correspondent at Washington states that Mr. Hay, Secretary of State, will notify to Germany that the United States looks favourably on Germany's proposal for an International control of wireless telegraphy.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—May 7th. A 20-ton electrical overhead crane for the Dee Village electricity works. See "Official Notices" April 11th.

Barrow-in-Furness.—May 7th. Arc lamps, columns, switch-pillars and sundry materials for the Corporation. See "Official Notices" to-day.

Bath.—April 21st. Steam dynamos, motor-alternator, balancer, switchgear, transformers, water softener, arc and glow lamps, cables and meters, &c. See "Official Notices" April 11th.

Bexley.—April 21st and 28th. Tram rails, fishplates, &c., also engines, alternators, and dynamos, for the U.D.C. See "Official Notices" March 28th.

Burton-on-Trent. — April 22nd. The Corporation wants tenders for the construction of about 5¾ miles of route, single line with passing places; consulting engineers, Messrs. Kincaid, Waller & Manville.

Bury.—May 8th. Tramway feeders, conduits, and street-work for the Corporation. See "Official Notices" to-day.

Cleckheaton.—May 3rd. Direct current motors for the U.D.C. See "Official Notices" to-day.

Dundee.—April 24th. Triple-expansion engine and 750-kw. dynamo for the electricity department. See "Official Notices" April 4th.

Edinburgh.—April 28th. Electricity meters for 12 months. See "Official Notices" April 11th.

France.—The French Post and Telegraph authorities in Paris are inviting tenders until May 1st, for the supply of 695,000 porcelain insulators in eight lots. Particulars may be obtained from, and tenders are to be sent to, Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

(*Continued on page* 651.)

THE BERLIN OVERHEAD AND UNDERGROUND ELECTRIC RAILWAY.

Before commencing a detailed description of the combination overhead and underground electric railway which has recently been completed in Berlin, a little space may be devoted to a brief *résumé* of the history of the undertaking, which dates back to 1880. In that year Werner Von Siemens, as a result of his miniature electric railway—the first of the kind—in the grounds of the Berlin Industrial Exhibition in 1879, drew up plans for a proposed overhead electric railway in the Friedrichstrasse, Berlin. Although the scheme was not proceeded with owing to the fact that the thoroughfare was found to be not sufficiently wide, the ever increasing demands for improved transport facilities in the German capital caused Messrs. Siemens & Halske to apply themselves to the working out of a plan to equip Berlin with a system of electric railways independent of the tramway routes.

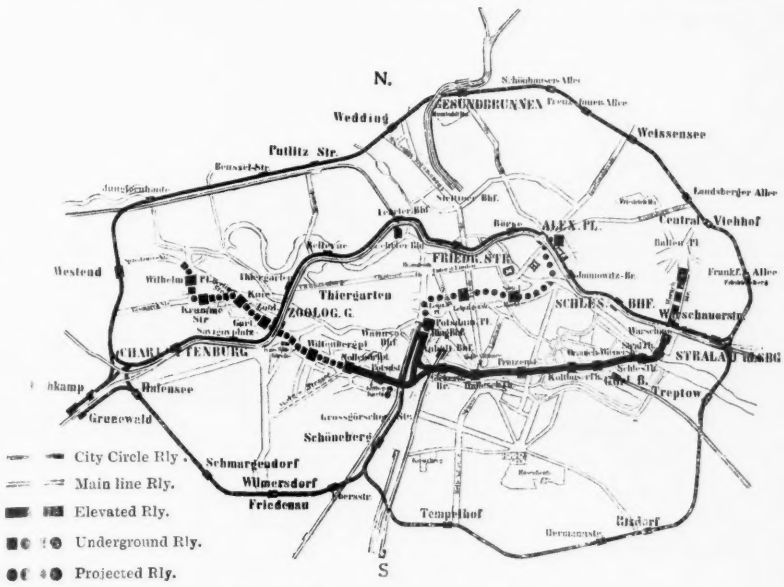


Fig. 1.—Map of Berlin Railways.

After many years' labour the firm laid before the German Ministry of Public Works a project for the construction of an overhead railway, 8½ kilometres long, to connect the eastern and western parts of Berlin, extending from the Warsaw Street Station of the Berlin Metropolitan Railway to the Zoological Gardens. The original route, which took in the central portion of the city, did not meet with approval, and eventually the one shown in the map (fig. 1) was decided upon. Owing to the alteration of route, a branch to the Potsdam Railway Station, in order to tap the traffic in the city, was proposed and agreed to, and the scheme received the Royal assent in May, 1893. While the construction of the line, which, in the original plans, was to be overhead the whole of its length, was in progress, it was found necessary to make an important alteration, viz., that from the Nollendorf Platz, westwards, would have to be underground instead of overhead. The change was partly due to the municipal authorities of Charlottenburg deciding in favour of the former system, and after a long period of negotiation a 90 years' concession was granted in 1896 and 1897, and the Royal assent to the alterations given in December, 1899. Since then an arrangement has been concluded with the municipal body concerned for the extension of the line—underground—from the Zoological Gardens along the route shown in broken lines in the map (fig. 1) to the centre of Charlottenburg. Naturally the question of transferring the trains from an overhead line to an underground one was the cause of much study, and after many plans and proposals had been considered, the establishment of an incline between the Nollendorf Platz and Eisenach Strasse was decided upon.

Protracted negotiations were necessary with the municipal authorities of Berlin, Schöneberg and Charlottenburg, and with the State Railway authorities and private owners with reference to the use of land, but finally all was

Oberbaum Bridge, and Stralauer Thor Station.

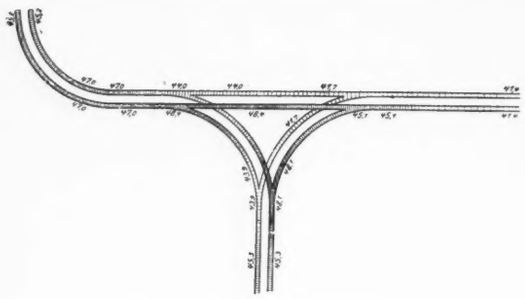


Fig. 2.—Triangular Junction.

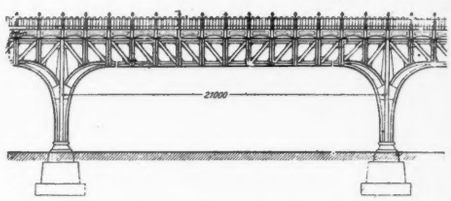
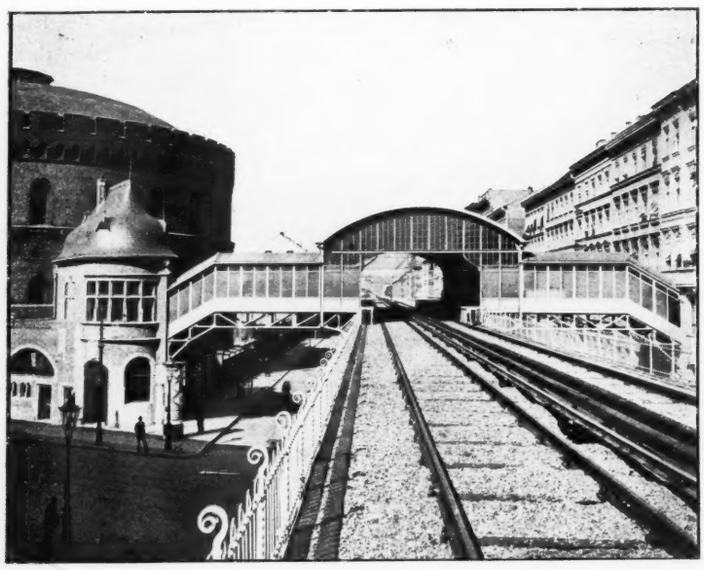


Fig. 3.—Elevation of Viaduct.

satisfactorily arranged, the Berlin municipality in addition placing at disposal a large area between the Warsaw Strasse and the Warsaw Platz for use as a terminal station. The three municipal bodies concerned are each to receive a certain percentage on the receipts, and have, at the end of the 30th year, in accordance with the Light Railway Law, the option of acquiring and taking over the line. To the State Railway authorities a fixed annual sum is to be paid in return for the use of the land and other concessions made.



Prinzenstrasse Station.

Under the auspices of the Deutsche Bank, Die Gesellschaft für Electrische Hoch und Untergrundbahnen in Berlin was launched in April, 1897, for the purpose of constructing and working the line, an agreement being entered into by the company with Messrs. Siemens & Halske, whereby the latter concern was to construct and equip the line. The work of construction occupied a period of $5\frac{1}{2}$ years. Work on the eastern section was commenced in the autumn of 1896, and the part between the Hallesches Thor and the Oberbaum Bridge completed, with the exception of the stations, by the end of 1899. The remaining portion of the eastern section occupied a much longer time, owing principally to the important buildings at the Warsaw Strasse terminus and to the station at the Schlesisches Thor, which latter was not completed until the middle of 1901. On the western section work was commenced in 1898, the line along the Hallesches bank at the side of the Landwehr Canal being the first to receive attention. Subsequently the most difficult part of the overhead line—the triangular junction, the bridges over the State Railways, the station at the Hallesches Thor, and the branch line to the Potsdamer Platz—was taken in hand, the last named being only completed in the autum of 1901. Simultaneously the erection of the viaduct and stations in the Bülow Strasse and the Nollendorf Platz and the construction of the underground portion of the route were in progress, with the result that the whole line was completed by the end of 1901.

With the view of reducing the cost of installation and to facilitate the construction of the line in certain thoroughfares of Berlin, the normal standards of ordinary railways were not entirely adhered to. At the same time, the establishment of a double track throughout was decided upon, the track itself being the same as the railway standard, so that, should occasion arise, the rolling stock of the electrical railway can be taken over ordinary railways.

On the overhead portion and on the inclines the distance from the centre of one track to that of the other is 3 metres (9·84 ft.), while in the tunnels, owing to there being central supports, it is 3·24 metres (10·6 ft.). There are no curves on the line with a radius of less than 80 metres (262·4 ft.), while the steepest gradient (except on the inclines, where it is 1 in 32) is 1 in 38. Including the two termini, there are altogether 13 stations on the line; they have been located at important street crossings, where there is usually a heavy pedestrian traffic.

Potsdamer Platz Station.

At the same time, efforts were made to locate the stations at equal distances, so as to get the full advantage of the

Viaduct in the Bülowstrasse.

maximum speed allowed. The average distance between stations is 900 metres (984 yards), the minimum distance—between the Stralauer Thor station and the Warsaw Strasse

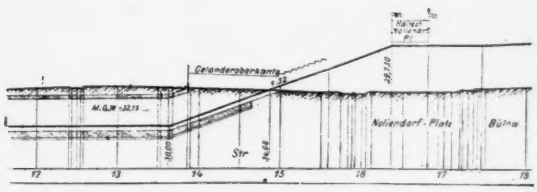


Fig. 5.—Diagram of Incline.

terminus—being 322 metres (352 yards), and the maximum—between the Bülow Strasse and the Potsdamer Platz stations—1,923 metres (1 mile 342 yards). Eventually the

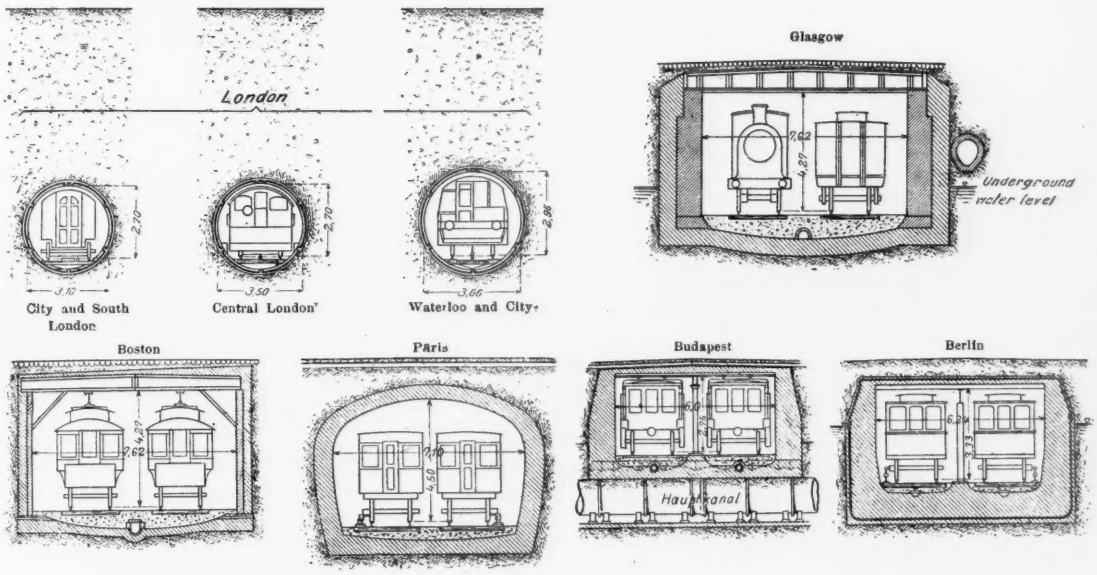


Fig. 6.—Comparative Sections of Various Underground Electric and Steam Railways.

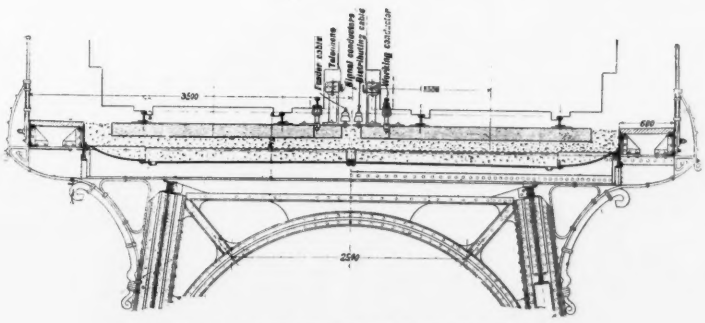


Fig. 4.—Cross-Section of Elevated Track.

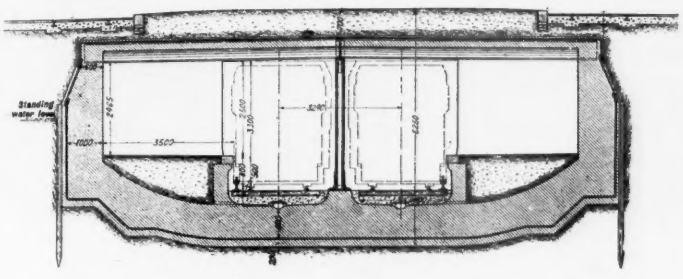


Fig. 7.—Cross-Section Through the Wittenberg Platz Station.

section between the Schlesisches Thor and Stralauer Thor stations will be the shortest, as it is intended to build a new terminus on the eastern side of the Warsaw Strasse State Railway station. The length of the whole line, as at present completed, is 10 kilometres 530 metres (6 miles 953 yards).

It is not necessary for our purpose to describe at length the architectural features of the line and stations. An idea of these will be gathered by a glance at several of the illustrations given herewith, from which it will be seen that no expense has been spared in making the viaduct and buildings worthy of the undertaking.

With but one or two exceptions, all the thoroughfares along which the line runs are wide and provided with a central walk for pedestrians, the width — from building to building—ranging from 31 to 52 metres (100 to 170 ft.). Except in certain parts, the viaduct is built over the central strip, which in the Bülow Strasse and the Skalitzer Strasse has an extreme width of from 11 to 15·3 metres (36 to 50 ft.). Thus there is ample space for a large roadway for vehicular traffic on each side of the viaduct. At one part of the Gitschinerstrasse

the central path only measures 6 metres (19·6 ft.) over all, but even here it was found possible to erect the viaduct without interfering with the thoroughfare. Along the Hallesches bank of the Landwehr

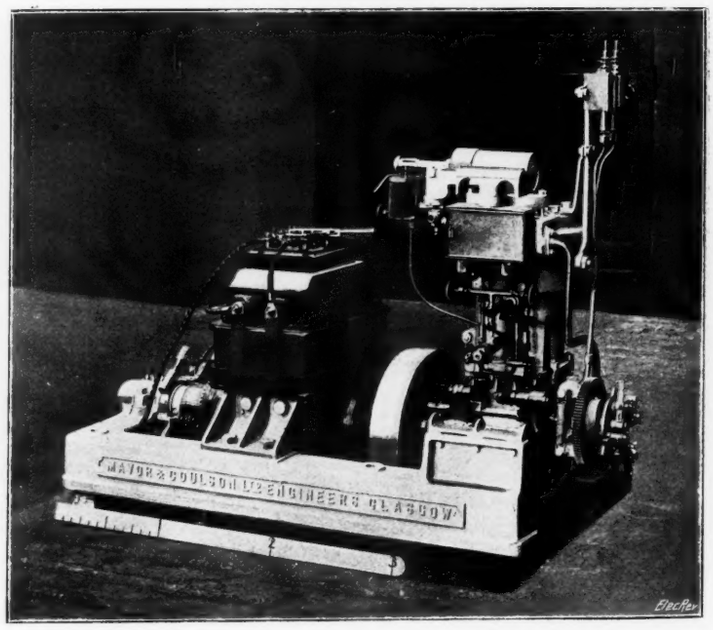
Archway at Tempelhofer, and Power Station.

Canal the viaduct does not occupy any part of the road, but is carried on masonry supports built on the canal bank. Four waterways are crossed by the line—first, over the River Spree by the Oberbaum bridge; second, over the Wasserthor basin near the Elisabet-ufer; third, over the Landwehr Canal; and fourth, on the branch to Potsdamer Platz, again over the canal.

One of the most important parts of the line to construct was the triangular junction rendered necessary by the branch line to Potsdamer Platz. It is situated on the 10,000 sq. metres of land leased from the State Railway authorities. Notwithstanding that the smallest radius of curve permitted was adopted, the junction occupies an area of 8,000 sq. metres, and has sides 250 metres (820 ft.) long. Owing to the track being a double one, there would, at this triangular junction, had the ordinary system been adopted, not only have been several branching-off points, but also numerous crossings. The latter, even with the most perfect method of signalling, would, owing to the height of the viaduct, have been somewhat dangerous, while much time would have been lost owing to trains having to wait while others passed over the crossings. To get over these difficulties, the interesting plan depicted in fig. 2 was adopted, the different tracks being carried over and above one another in an ingenious manner, and this without exceeding the scheduled maximum gradient of 1 in 38. The change in the level of the up and down tracks necessitated, of course, a separation of the double track viaduct into separate single-track ones. Naturally, although the arrangement adopted caused a large increase in the first cost of the line, the facility with which the trains get over the triangular junction, owing to there being no crossings, has greatly increased the carrying capacity, and consequently the earning capacity, of the line.

In view of the relatively high undergound water level, and in order to keep down the cost, it was necessary to make the underground tunnel as near the road surface as possible. At the same time the requirements of the municipal authorities had to be adhered to, those of Charlottenburg insisting upon a distance of 70 centimetres (27½ in.) between the upper edge of the tunnel roof and the surface of the road. Only at the underground stations is this distance reduced to 40 centimetres (15¾ in.). The top of the rails in the underground portion of the line is, on the average, 14 ft. 5 in. below the road, there being but little variation in the level on this section. Notwithstanding the relatively level nature of Berlin, there is, however, a distance of about 65 ft. between the lowest and highest points on the whole line, the highest part being on the viaduct over the Circle Railway.

Passing to the structural features of the line, it may here be mentioned that the length of the steel viaducts and bridges (excluding stations) is roundly 4 miles 940 yards; that of the masonry viaducts and bridges (including stations) 1,049 yards; that of the underground portion, 1 mile 98 yards. Under the conditions imposed, the viaduct in the public thoroughfares was to be so constructed as not to prevent the use by the public of the portion of road below it, nor to prevent one side of the road being seen from the other, and it was these conditions that necessitated the employment of an iron viaduct for the bulk of the line. Various types of viaduct have been adopted, the one mostly used being that in which the supports are rigidly connected with the girders and pivoted at their base, to provide for the effect of varying temperatures on the viaduct. This method has also the advantage that the supports have only the weight of the girders to carry, no other moments being set up. The supports are connected to the girders by curved arms, giving the viaduct a pleasing appearance. The distance between the supports differs according to the height of the viaduct; at parts it is 39·3 ft.; at the stations, 49·2 ft.; at certain points, 54 ft.; and at others, 68·8 ft. The inside width of the viaduct, on the track, is 7 metres (23 ft.), thus leaving room for a narrow footpath on each side of the lines. An elevation of the viaduct on the Hallesches Bank of the Landwehr Canal is shown in fig. 3. With the view of having the overhead stations at as low a level from the street surface as possible and yet to have a reasonable height of clear way under the bridges over the main cross thoroughfares, the distance between the road at crossings and the underside



Direct-Coupled Oil Engine and Dynamo. (See Page 651.)

of the viaduct was fixed at 14 ft. 11 in. Other special points which had to receive attention were—(1) The viaduct along the public thoroughfares had to be watertight, that is to say, no water must be allowed to drip on to the roadway ; and (2) the noise caused by the trains had to be reduced to a minimum, one of the methods adopted of meeting these requirements being illustrated in fig. 4. At the triangular junction at the eastern extremity of the line, and on the land not open to public traffic, the overhead portion of the railway is carried on a steel viaduct, which in turn rests on masonry arches. Some of this combination steel viaduct and masonry work is of a very complex character, particularly at one point, where it has in its width to support four bridges, each at a different level, and at another where one line is immediately above the other.

The difference of level of 30 ft. between the overhead and underground portion of the line near the Nollendorf Platz, at the western end, is overcome by an incline having a gradient of 1 in 32 (see fig. 5). The branch line terminates in a tunnel under the Potsdamer Platz State Railway station by an incline having a gradient of 1 in 38, about 65 yds. of the incline being in the tunnel. The greater part of the inclines is carried on a steel viaduct, but the portion near the ground level consists of an embankment with masonry supporting walls.

Some brief particulars of the underground portion of the line have already been given. The illustration (fig. 6) is interesting as enabling a comparison to be made of the section of the tunnel in Berlin with those of the underground railways in London, Glasgow, Boston, Paris and Budapesth. It is formed throughout of a thick layer of rammed concrete in which a protective layer of bitumen is interposed. Along the centre of the tunnel is a continuous line of steel columns serving to support the tunnel roof, while at intervals of 82 ft. along the sides of the tunnel are openings serving as supplies' stores and safety recesses for plate layers and other railway employés, extra provision for the safety of whom is found in the space between the central columns and the two tracks. The roof of the tunnel is carried on steel beams of I section, fixed at distances varying from 1 to 1½ metres (3·28 to 4·9 ft.), the central portion of these beams resting on I beams supported on the central columns. The roof consists of concrete, filled in between the beams, a slight variation in method being adopted where gas and water pipes and other mains have had to be carried over the underground portion of the line. The inside of the tunnel is 6·24 metres (20 ft.) in width, increasing at the stations to 12·64 metres (41·45 ft.). The foregoing particulars of the tunnel refer to the underground portion between the Nollendorf Platz and the western terminus. In the underground part of the Potsdamer Platz branch the walls of the tunnel are close up to the foundations of the neighbouring buildings, which had to be extended to a further depth of from 7 to 14 ft. before the construction of the tunnel could be commenced. Beyond the branch terminal station the tunnel is continued for a length of about 200 ft., to accommodate a single line, used to enable the trains to be transferred from the up to the down line in the station. The tunnels were constructed in the form of deep cuttings, being afterwards roofed in as shown in fig. 7. An extensive pumping plant was necessary to keep out the underground water during the construction of the tunnel. The work was also rendered somewhat difficult, owing to the many gas, water, and other mains which had to be dealt with without in any way preventing their use. Provision is made so that any water which may collect in the tunnels during a period of heavy rain, can quickly be carried away, so as not to interfere with the working of the line.

(To be continued.)

DIRECT-COUPLED ENGINE AND DYNAMO.

The high-speed oil engine which has been developed primarily for propelling automobiles will find other spheres of usefulness. Its application to dynamo driving is illustrated on the opposite page. This set has been made to the order of Mr. J. E. Waller, M.Inst.C.E., for the electric lighting of his seaside residence. The engine is of the Daimler Company's standard type, with the addition of a simple form of "hit-and-miss" centrifugal governor. It is designed to develop 6 B.H.P. at 720 revolutions per minute, and is fitted for both tube and electric ignition. The dynamo is of Messrs. Mavor and Coulson's standard bi-polar type, giving an output of 4 KW. It is shunt-wound for charging accumulators at 720 revolutions per minute, and has compound winding for supplying the lamps direct at 600 revolutions per minute. A two-way switch is fitted to the magnets for cutting the series coils in or out of circuit.

The combined set is exceedingly compact, and is so arranged that perfect freedom of access to the parts is provided. When these engines are employed for stationary purposes, some of the complications attending their use on automobiles are avoided, as, for example, the replacement of the pressure system of feed for the fuel oil and the water circulating pump by gravity, the oil supply tank and water cistern being fixed above the engine. The cost of the combination described is considerably less than that of an ordinary horizontal engine and belt-driven dynamo of equal output. It occupies much less space, and requires a small foundation. So simple a plant does not require skilled attendance for its operation, but only ordinary intelligence, and in these days of bicycle and motor cars, when every man is more or less his own mechanic, it should have a wide field of usefulness. Engines which work well under the conditions of vibration and dust or mud inseparable from the motor car, may be expected to work still more satisfactorily when fixed on a rigid base and housed in a clean dry place. The set is admirably adapted for the electric lighting of country houses of moderate size, and its portability specially adapts it for export. For the tropics it is specially recommended, as for electric lighting and for driving electric punkah pullers, fans, &c.

CONTRACTS OPEN.

(*Continued from page* 646.)

Fulham.—April 29th. Switchboard work for the Guardians. See "Official Notices" to-day.

Fulham.—May 5th. One 600-KW. two-phase steam alternator, or Parsons turbo-alternator for the electricity works. See "Official Notices" to-day.

Glasgow.—April 21st. Concentric and single main cables for electricity department. See "Official Notices" April 4th.

Kingston-upon-Hull.—April 24th. Pipework, pumps, motors, &c. See "Notices Official" April 11th.

London.—April 22nd. The L.C.C. wants tenders for 48 miles of extra-high-pressure three-core lead-covered paper-insulated cables; 87 miles of low-pressure single ditto; and 14 miles dry core telephone cable for the tramways. See "Official Notices" April 4th.

London.—April 23rd. High and low-pressure switchboards at the Grove Road generating station of the Central Electric Supply Company. See "Official Notices" March 28th.

London.—May 1st. The L.C.C. wants tenders for electric lighting of the Euston Road fire station. See "Official Notices" to-day.

Luton.—April 25th. Distributing mains. See "Official Notices" April 11th.

Lytham.—April 26th. 300-KW. plant for the electricity supply and tramways station, including battery, booster, transformers, feeders, mains, arc lamps and posts, &c. See "Official Notices" April 11th.

Mansfield.—May 1st. Pipework, valves and tanks for the electricity works. See "Official Notices" April 4th.

Nelson.—April 28th. Rails, overhead equipment, pillars, cable, tramcars, &c. See "Official Notices" April 11th.

Oldham.—May 6th. Switchboards (lighting and traction). See "Official Notices" April 11th.

Penang.—April 28th. Boilers, condenser, pumps, pipes, steam dynamos and balancer booster, switchboards, batteries, cables, junction boxes, arc and glow lamps, posts and accessories, for the commissioners of George Town. See our "Official Notices" March 14th.

Rathmines.—April 24th. 300-KW. steam dynamo, switchboard and mains. See "Official Notices" March 21st.

Rhyl.—April 28th. The U.D.C. wants tenders for wiring the Town Hall. Tenders to the Clerk, Council Offices, Clwyd Street.

Rotherham.—April 23rd. Rolling stock, overhead work, and permanent way, for Corporation electric tramways. See "Official Notices" March 28th.

Spain.—April 20th. The *B. of T. Journal* recently contained notice of a call for tenders to take over and work the electric light installation of the town of Irún, which was unsuccessfully offered some months ago. Particulars at the B. of T. Offices.

Stepney.—May 1st. Meters and demand indicators for the B.C. See "Official Notices" to-day.

Stockport.—April 23rd. One 200-KW. engine and dynamo for traction purposes. See "Official Notices" April 11th.

Sudbury.—May 1st. Water-tube boiler, pipework, steam dynamos, boosters, batteries, switchboard, mains, station lighting, &c. See "Official Notices" April 11th.

Swindon.—April 23rd. Feeder and distributing cables, conduits &c., for electric lighting. See "Official Notices" April 4th.

Sydney.—May 7th. Messrs. Preece & Cardew, on behalf of the Municipal Council, invite tenders for equipment of electricity works and sub-stations. Water-tube boilers, three-phase steam alternators, battery, motor-generators, stationary transformers, switchboards, &c. See "Official Notices" March 21st.

Trowbridge.—April 30th. The U.D.C. is open to receive applications for a lease of its electric lighting powers.

West Ham.—May 13th. Two steel chimneys, four fans, and engines for induced draught, brickwork, economisers, &c., for the Corporation. See "Official Notices" to-day.

West Hartlepool.—April 30th. 200 to 250-KW. engine and dynamo for the electricity works extensions. See "Official Notices" April 4th.

Whitby.—April 25th. Meters for the U.D.C. electricity department. See "Official Notices" to-day.

CLOSED.

Bradford.—The Corporation has accepted tenders as follows:—Willans & Robinson, Limited, spare parts for six Willans engines, £143 15s. 0d.; Bruce Peebles & Co., two 15-H.P. motors for £190 19s. 0d., and one 30-H.P. motor for £155; and Messrs. Ferranti, Limited, extension of a lighting switchboard, £128.

The Corporation has also accepted the offer of the Brush Electrical Engineering Company, Limited, to supply 100 sets of slipper brake materials and attach them to trucks at the price of £6 10s. 0d. per set. The advertising on the cars has been let to a contractor for five years at the rate of £25 per car for the first 128 cars and £20 per car for all additional cars.

Bristol.—The following is a list of the tenders submitted to the electricity department (Mr. H. Faraday Proctor), for a 210-KW. multipolar direct current generator to be installed at the Temple Back electricity works. The contract has been given to Messrs. Dick, Kerr & Co., Limited:—Siemens, Bros. & Company; British Westinghouse Company, Limited; Crompton & Company; British Schuckert Company; Lancashire Dynamo and Motor Company; Bergtheil & Young; T. Parker & Co.; India-Rubber Company; Electric Construction Company; E. Scott & Mountain; Johnson & Phillips; Johnson-Lundell Traction Company; C. A. Parsons & Co.; Brush Electrical Engineering Company; Mather and Platt; Greenwood & Batley; Fuller-Wenstrom & Co., Limited; Bruce Peebles & Co; International Electric Engineering Company; Mavor & Coulson; Dick, Kerr & Co. (*accepted*); Lahmeyer Electrical Company.

Edinburgh.—Messrs. Sykes, Richardson & Hill, of Glasgow, have secured the contract for an electric power installation at the new premises of Messrs. Robert Younger, Limited, at Easter Road, Edinburgh.

Hackney.—The Hart Accumulator Company recently secured from the Borough Council the contract for renewing the storage battery of 120 cells at the Hackney public baths with their standard lighting type sections.

King's Lynn.—The T.C. have accepted the tender of Messrs. Summers & Scott, for engines and pumps for the Gayton works at £1,750.

Limerick.—Mr. Patrick Bourke has obtained the contract for the erection of the generating station, Frederick Street, Limerick, in connection with the electric lighting scheme of that town. The station is to cost £2,650.

Liverpool.—We learn that the Corporation have renewed their contract for the supply of incandescent lamps for the ensuing year with the Electrical Company, Limited.

Melbourne.—An Australasian exchange says that the City Council recently gave an order for nearly one million arc lamp carbons of Conradty's manufacture to the Austral Otis Engineering Company. Launceston Council also placed a contract for arc carbons with the same company.

Newcastle-on-Tyne.—The Council on the 9th inst., accepted the tender of Messrs. Elliott, Bros., of Newcastle, for the construction of shops at Gosforth electric tram car sheds, the cost being £4,459 1s. 10d.

Sunderland. — The T.C. has accepted the following tenders:—

Mr. Thos. Lumsdon, Gateshead, machine tools.
Messrs. Doulton & Co., stoneware casings.
Vacuum Oil Company, oil.
Messrs. W. T. Glover & Co., Ltd., of Manchester, india-rubber covered cables.
Messrs. Watson, Gow & Co., Glasgow, cast-iron pipes.

Spain.—La Compania de Productos Celuloideos y Refinacion de Alanfor, of Madrid, has secured a contract from the Spanish Ministry of Posts and Telegraphs, for 12,000 celluloid insulators.

Swansea.—The E.L. Committee has decided to accept the tender of the Westinghouse Company at £14,520 for the erection of dynamos and engines in connection with the scheme for trebling the capacity of the electric lighting works. The other tenders chosen for final selection were those of Messrs. Dick, Kerr & Co. and the Schuckert Company, the former being £760 and the latter £790 below that of the Westinghouse Company.

FORTHCOMING EVENTS.

Saturday, April 19th.—At 3.0 p.m. National Association of Electrical Contractors (Northern Section). Meeting at the Exchange Station Hotel, Liverpool.

At 1 30 p.m. National Association of Electrical Contractors (Northern Section). Meeting of the Executive and Delegates of the Local Associations.

Tuesday, April 22nd.—At 7.30 p.m. Institution of Electrical Engineers (Students' Section). Extraordinary meeting to be held at the Finsbury Technical College. Paper on "The Wehnelt Interrupter," by Mr. P. Laubach.

Wednesday, April 23rd.—At 8 p.m. Institution of Civil Engineers. Special meeting. Tenth "James Forrest" lecture, by Sir William C. Roberts-Austen, on "Metallurgy in Relation to Engineering."

Thursday, April 24th.—At 8 p.m. Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers. Adjourned discussion on paper on "Problems of Electric Railways," by James Swinburne and W. R. Cooper. "Form of Model General Conditions, for use in connection with Contracts for Plant, Mains, and Apparatus for Electricity Works;" as drafted by a Committee, and presented to the Council for adoption as the Model General Conditions recommended by the Institution of Electrical Engineers. The announcement of the Council nominations for the Council for 1902-1903 will be made at this meeting.

Friday, April 25th.—At 5 p.m. Physical Society. Meeting in the rooms of the Chemical Society. Papers on "An Exhibition of a Mechanical Break for Induction Coils," by Dr. Dawson Turner, and "A Temperature Indicator for use with Platinum Thermometers, in which Readings are Automatically Reduced to the Gas-Scale," by R. S. Whipple.

NOTES.

Düsseldorf Exhibition. — The Düsseldorf Art and Industrial Exhibition, which is to be opened on May 1st, promises to be of an important character, very large spaces having been taken by the leading iron and steel concerns in Rhenish-Westphalia. The Exhibition will run for a period of six months, and an idea of its importance may be gathered from the fact that the central electric lighting and power station that has been established in connection with it has a capacity of 6,000 H.P.

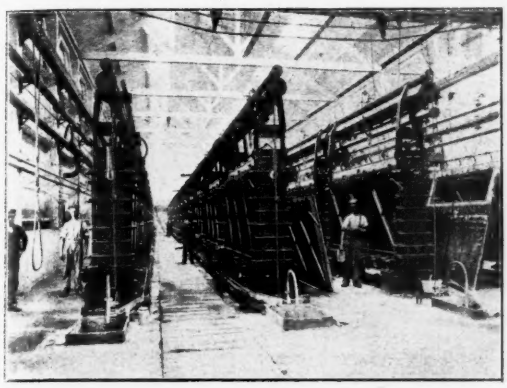
German Electro-Chemical Society. — The annual meeting of the Deutsche Electro-chemische Gesellschaft is to be held at Wurzburg, Germany, from May 8th to 10th next. No less than 27 papers are down for reading at the meeting. Among them we note one by Herr F. Foerster on "The Electrolysis of Platinised Electrodes," one by Herr C. Liebenow on "The Application of the Fuchs Measuring System in Accumulator Practice," and one by Herr A. Coehn on "The Electrolytical Production of New Alloys."

High-Voltage Transmission.—The *Electrical World* says that the Union Traction Company, of Indiana, in the extensions of its large electric interurban railway network around Anderson, Ind., will employ 32,000-volt transmission lines for distributing electrical energy. The Economy Electric Light and Power Company, of Joliet, Ill., on its 35-mile transmission for operating the Bridgeport pumping station in Chicago will employ a similar voltage.

The Electricals.—This newly-formed society had its housewarming at the Bedford Head Hotel on Friday evening last, April 11th, very few seats remaining vacant. The supper was very well served, and a capital concert followed. In the absence abroad of the President, Sir David L. Salomons, Bart., the chair was occupied by the Vice-President, Mr. C. F. Quicke, M.I.E.E. The meetings are held every Friday, and are of a social nature only. Gentlemen desirous of joining should communicate with the hon. secretary, Mr. F. E. Oldham, 3, Orchard Road, Highgate, N.

Institution of Electrical Engineers (Manchester).—On Tuesday, April 15th, a paper on "The Treatment and Use of Air-Spaced Cables," was read by Mr. G. E. Fletcher.

The Hargreaves-Bird Electrolytic Process.—The works of the Electrolytic Alkali Company, at Middlewich, were started on a practical scale in April last year. In the cell room there is now working one unit, or 56 cells, 12 out of each 14 of which are always in operation at one time, the remaining two being held in reserve. The present scheme of the company is to have a total of 250 cells, or five times the existing plant. It is stated that from 4½ months' working of the one unit there has resulted a profit of £1,242, equivalent to a profit at the rate of £3,170 per annum, and during part of the time only a few of the cells were in actual operation. With the same plant they have earned profit at the rate of between £7,000 and £8,000 per annum. With the same ratio of profits, and five units working, the company expects to earn sufficient to pay 7 per cent. on £100,000 preference shares, or double



Ranges of Electrolytic Cells.

the existing issue, and more than 16 per cent. on the ordinary shares, when the further £100,000 now asked for in the prospectus, which appears in our pages this week, is subscribed. At present the capacity of their plant is quite unequal to cope with the demands for the products. The accompanying illustration shows an end view of the ranges of cells. As the prospectus shows, subscriptions are now invited for 50,000 7 per cent. £1 cumulative preference and 50,000 £1 ordinary shares at par. This capital, it is said, will be ample for carrying out the buildings and plant necessary for completing the second unit, and for erecting and fully equipping the third, fourth, and fifth sections of the extensions. The list of subscriptions will close on Thursday next, April 24th, for town and country.

Institution of Electrical Engineers (Glasgow Local Section).—On Tuesday evening, 8th inst., the chairman, Prof. Magnus Maclean, announced that in accordance with Clause 45 of the articles of association, the Council had prepared a list of nominations for the office-bearers for the next session, which he submitted to the meeting, as follows:—Chairman, H. A. Mavor; vice-chairman, W. A. Chamen; hon. sec. and treasurer, E. George Tidd; ordinary members of committee, A. R. Bennett, M. B. Field, W. McWhirter, Thos. Young, W. B. Sayers, J. M. M. Munro, W. B. Pickstone, Prof. A. Gray, and David Stewart (representing the associates). If any member had other names to propose, he could do so in accordance with the above-mentioned clause, which stipulates that such nominations must be in the hands of the secretary within seven days from the date of that meeting. Prof. Maclean, in introducing Mr. M. B. Field (member), who read a paper on "Notes on the Testing of Tramway Motors and Investigations into their Character," said that Mr. Field's paper had really been intended for the May meeting, but that owing to unforeseen circumstances the April paper had not come forward in time for the meeting, and Mr. Field had kindly stepped in and filled the gap. Mr. Field thereafter read his paper, which was followed with the closest attention, although it lasted about an hour and 45 minutes. After the reading of the paper, Mr. W. A. Chamen (member) congratulated Mr. Field on the ability displayed in the facts and figures he had laid before them, and moved that the discussion be postponed till the May meeting of the section. Mr. H. A. Mavor seconded, and the meeting was concluded by a vote of thanks to Mr. Field.

Messrs. Bruce Peebles and the Ganz System.—We learn that a contract and agreement have been entered into between Messrs. D. Bruce Peebles & Co. and Messrs. Ganz & Co., of Buda-Pesth, whereby the former firm have the sole manufacturing licence for Great Britain and the Colonies for all Messrs. Ganz & Co.'s three-phase manufactures. The best points of Continental design will, therefore, be embodied with highest class British workmanship and finish. Messrs. Bruce Peebles & Co. have acquired a large tract of land on which they will be capable of building machines up to 10,000 H.P. They have also taken up the Ganz system of electric traction, and the working application of this will be shown in this country as soon as possible.

Municipal Loans.—The Select Committee of the Commons on loans to local authorities sat again on 11th inst., and heard evidence by Sir Herbert Jekyll, assistant secretary of the Board of Trade, Mr. Lindsell, of the Education Department, and Mr. J. Lithiby, assistant secretary to the Local Government Board.

Electricity Works and Coronation Energy.—The following information has come to supplement that given in our article last week:—

Barrow-in-Furness.—Mr. H. R. Burnett: (1) None necessary. (2) Energy for outside illuminations probably free of charge. (3) No. (4) Electricity works, No; municipal buildings, by gas, electricity, or both.

Bradford.—Mr. R. A. Chattock: (1) Ample spare plant for this time of the year. (2) None arranged. (3) None so far. (4) A portion of the Town Hall is to be illuminated electrically, also some of the squares, open places and monuments. This will be carried out by the Corporation, and special designs have been submitted and approved by the Coronation Committee.

Carlisle.—Mr. C. D. Burnet: (1) None. (2 and 3) No. (4) Not decided.

Colwyn Bay.—Mr. A. R. Tudman: No!

Dover Electricity Supply Company.—Mr. L. W. Woodman: A considerable length of cable has been wired with lampholders every 12 in. in anticipation of demand, and the company is prepared to supply letters and crowns, &c. (2) Fixed charge per lamp, including energy, for existing consumers. (3) None offered, but for desirable consumers special facilities might be given. (4) Works, No; chimney, Very likely; municipal buildings, Probably.

Heckmondwike.—Mr. G. H. Carter: (1) None. (2) Engineer has recommended 3d. per unit. (3 and 4) Nothing settled.

Mexborough.—Mr. H. Waring: (1) None; others, No.

Nuneaton.—Mr. S. C. Gibson: (1) No; demand insufficient. (2) Where consumer fixes extra lamps, all energy consumed on his premises will be 3d. per unit. (3) Each case on its merits. (4) Under consideration.

Prescot and District Company.—Mr. R. P. Nash: (1) Plant sufficient. (2) For illumination purposes free. (3) No. (4) Not decided.

Reading Electric Supply Company.—Mr. A. T. Cooper: (1) Ample spare plant available. (2) 2d. per unit with meter and connection fee of 5s. per consumer. (3) Open to consider for large schemes. (4) Works probably, municipal buildings unsettled.

St. James's and Pall Mall E.L. Company.—Mr. F. J. Walker: Circular out since January 28th. Small devices which can be supplied through the consumer's existing service and meter, will be charged as ordinary lighting, with a fee of £1 1s. for attendance and inspection. Large devices will be supplied by special service and meter, and charged for at the rate of 6d. per unit, and the cost of laying the service. In view of the extra amount of work involved, all such applications must be delivered to the company at least one month before the date at which the illuminations are required to be used, and everything must be completed and in readiness for connection a fortnight before that date. The company cannot guarantee to supply unless this condition is strictly observed.

Southampton.—Mr. H. F. Street: (1) None. (2) Usual. (3) Nominal charge made to prevent a very small number of lights being applied for. (4) Yes.

York.—Mr. C. A. Midgley: (1) None. (2) 3d. (4) No.

Personal.—There were 115 candidates for the post of general manager of the Yarmouth Corporation new electric tramways, now approaching completion. Mr. F. L. Turner, of the Blackpool Corporation Tramways, was appointed.

A New York exchange says that Mr. Bernard Drake, of Messrs. Drake & Gorham, has just been on a business visit in the States.

The syndicate which has purchased the Isle of Man electric tramways system has appointed Mr. Frank Edmondson, who had been in the service of the old company for many years, and latterly as the assistant engineer, as its chief engineer for the entire system.

Marriage.—On Wednesday last week at Blackpool Mr. J. St. P. McMahon, chief electrical engineer of the Blackpool and Fleetwood Tramroad Company, was married to Miss Constance M. Carlisle. The gifts included a silver tea service from the bridegroom's fellow workers at the B. and F. T. Company.

Appointments Vacant.—Assistant electrical engineer at £130 for the Devonport Corporation. Inspector of fire alarms for Bradford Fire Brigade at £95. See "Official Notices" to-day.

Boilermakers' Wages.—We read in the *Times* that the employers on the north-east coast have given notice of a reduction of wages to the members of the Boilermakers' and Iron and Steel Shipbuilders' Society. The reduction is for 5 per cent. on piece rates and will take effect in about a fortnight's time. The reason given for the reduction is the falling-off in trade. Notices are being issued calling meetings of the men to consider the matter.

Train Lighting in Pennsylvania.—The Pennsylvania Railroad has put in service a train lighted by electricity, generated by storage batteries under each car. The present batteries will supply lights for 12 hours, and improvements are expected to be made whereby batteries can be installed that will furnish lights for 24 hours. It is said (*Electrical World*, New York) that all the through trains of the Pennsylvania Railroad will be furnished with these storage batteries.

Liverpool Extension Contracts.—The City Council on Wednesday accepted the tender of the British Thomson-Houston Company for three high-tension steam dynamos for the Lister Drive station, and six sets of sub-station transformers, at a cost of £22,059. The contract for three sets of direct-current steam dynamos for the Pumpfields station was given to Messrs. Willans & Robinson, at £6,921, less 2½ per cent.

Fund for the Endowment of University Education and Research.—We are asked to publish the following appeal:—

"May I ask for space in your columns to call public attention to the appeal now issued by University College, for funds in aid of higher education and research in London?

"By the new statutes of the University of London a Teaching University has been created. It is impossible, however, for the University to exercise its proper functions with regard to teaching and research until it has capital funds and adequate buildings at its disposal. The part of the Imperial Institute allocated to the University does not more than suffice for the purposes of examination and secretariat.

"University College, London, has from its foundation, 75 years ago, been a seat of University education and research. Its yearly output of original work is not exceeded by that of any University in the land. Its buildings, freehold land, and endowments represent a capital value of at least £800,000, and its present accommodation could be trebled by the extension of the buildings in its own grounds. It is evident, therefore, that the policy of incorporating the College in the University is an important step in building up the Greater London University on existing institutions.

"In order to aid the policy of incorporation the Drapers' Company have offered £30,000 to the University; and for the same purpose a former student has offered an equal sum to University College.

"But these sums are quite insufficient. A further sum of £110,000 is required in order to free the whole of the existing College buildings for University purposes, and render incorporation possible.

"Much larger sums, amounting in all (including the £110,000 already mentioned) to over a million, are necessary in order to perfect and complete the College, and to render incorporation fruitful by placing at the disposal of the University funds sufficient to complete the college equipment for higher teaching and research. The estimated sums may be divided as follows:—

"(*a*) £250,000 for completing the College buildings, thus providing adequate accommodation for teaching and research in such important departments as modern languages, chemistry in all its branches, geology, physiology, botany, engineering in all its branches, advanced medical studies, &c.

"(*b*) An annual income of £6,000 a year, or a capital sum of £200,000 for departmental expenses, including maintenance of laboratories, libraries, &c.

"(*c*) A yearly sum of £20,000, or a capital sum of £700,000, for the endowment of existing unendowed Chairs, and for the foundation of additional Professorships and Lectureships.

"The great need of our country at the present time is an increase in the supply of men with trained brains—men who will act as leaders in the world of thought and of affairs, and in the struggle for mastery over the forces of Nature. The recent industrial development of Germany, the growing ascendency of America, are largely due to the recognition of this fact, and to the provision by the State, or by private individuals, of the necessary means, of Universities well equipped with laboratories and well supplied with endowments.

"I earnestly appeal, therefore, to everyone who has the interests of his city and country at heart, to help in thus developing the University of London, so that it may be worthy of the capital, and a fruitful source of power to the Empire.

"A public meeting has been arranged to take place in support of the scheme at the Mansion House on May 9th, and the Lord Mayor has kindly consented to preside.

"A detailed statement of the needs of University College, London, with some account of its previous history, and the part it has already played in the increase of knowledge, has been drawn up in support of the appeal, and may be had on application to the secretary at the College.

"Donations and subscriptions should be sent to the treasurer, Sir R. Farrant, at the College.

"(Signed) Reay, *President.*

"University College, London,
"Gower Street, W.C.,
"*April 11th*, 1902."

It was announced yesterday morning that Mr. W. W. Astor had sent a donation of £20,000 to the fund.

Our Tramway Contemporary.—The *Tramway and Railway World* Publishing Company, Limited, established in 1892, has been voluntarily wound up, and a new company with the same title and capital has been registered. The new company will carry on the business of the old company, and the re-organisation will involve no change in the management, staff or policy of the *Tramway and Railway World.*

Obituary.—We regret to announce the death, at the age of 61, of M. Alfred Cornu, member of the Academy of Sciences, of Paris, whose experiments on the velocity of light perfected the method of Fizeau.

Motor Cars at Boston, U.S.A.—A Chicago exchange says that the Boston Legislature has passed a Bill regulating the speed of automobiles to 15 miles an hour outside the limits of a city or thickly settled part of a town, and to 10 miles an hour within those districts.

THE CENTRAL STATION ENGINEER.

The Devonport Council last week confirmed the appointment of Mr. J. W. Spark as borough electrical engineer, in place of Mr. Chas. Furness, who goes to Blackpool. The works are now practically ready to give a supply of energy. A chief assistant is to be advertised for at £130.

On the 8th inst., Mr. C. A. Bowen, assistant engineer at the Chatham Electricity Works, was presented with a pen and ink stand on the occasion of his marriage.

On Thursday last week the Mayor of Bath presented 10 members of the staff with the honorariums granted by the Council for loyal work during the breakdown of November. The Electric Lighting Committee had allotted 50 guineas to Mr. Teague, and the remainder of £150 to the other officials. The Mayor said it was his duty to thank the staff, on behalf of the Council and citizens, for having done so very well in the November mishap. It was their wish to recognise the voluntary efforts of the staff to minimise the inconvenience which was felt at the time of the breakdown. Mr. Isaacs endorsed the remarks of the Mayor. There was not a man who attempted to shirk his duty. It was very satisfactory to think that they had such an able and willing staff. Light refreshments were provided, and Mr. Teague, proposing the health of the Mayor, said the Mayor and Council had in a handsome way recognised the work that had been done, simply because the staff had carried out its duty when the occasion arose. If the staff had merely had the thanks of the Council they would have considered themselves satisfied. Mr. A. G. D. Moger, on behalf of the Council, said they had the fullest confidence in Mr. Teague, who, they believed, was a man they could thoroughly trust, and in his staff.

The Croydon County Council has appointed Mr. J. Gray Scott, burgh electrical engineer of Leith, to the office of Corporation electrical engineer, at a salary of £400, rising to £600.

NEW COMPANIES REGISTERED.

Industrial Electric Company, Limited (73,266).—This company was registered on March 29th, with a capital of £2,000 in £1 shares, to acquire the business carried on by S. Raphael and J. Gray, as the Industrial Electric Company, at Egremont, Ches., and to carry on the business of manufacturers of and dealers in electric fittings, motors, lamps, switches, insulators, bells, and other electrical appliances and apparatus, mechanical and electrical engineers, fitters, founders, platers, &c. The first subscribers are:—S. Raphael, Marine View, Promenade, Egremont, electrical engineer, £0 shares; J. Gray, 150, New Chester Road, Birkenhead, electrical engineer, £0 shares; Mrs. A. Gray, 150, New Chester Road, Birkenhead, 5 shares; H. D. Findlay, Marine View, Promenade, Egremont, electrician, 1 share; F. F. Scott, 83, Victoria Road, New Brighton, butcher, 1 share; C. J. Holmes, Market Gate, Warrington, merchant tailor, £0 shares; W. Russell, 7, Suez Street, Warrington, livery stable keeper, 1 share; and E. G. E. Snow, 89, Victoria Road, New Brighton, grocer, 1 share. Minimum cash subscription, £100. The number of directors is not to be less than two nor more than five; the first are S. Raphael and J. Gray; qualification, 50 shares.

R. D. Cassells & Co., Limited (5,058).—This company was registered in Edinburgh on March 29th, with a capital of £3,000 in £1 shares, to acquire the business of the late Robert D. Cassells, electrical engineer and contractor, carried on at 168A, St. Vincent Street, Glasgow, as "R. D. Cassells and Co.," together with the whole plant, premises, implements, furniture, and goodwill, and to carry on the business of electrical and mechanical engineers, contractors, &c. The subscribers (each with one share) are:—Robert Livingston, 168A, St. Vincent Street, Glasgow, electrical engineer; James Davies, jun., 168, St. Vincent Street, Glasgow, chartered accountant; J. M'Dermott, 168A, St. Vincent Street, Glasgow, electrician; W. Couper Tait, 168, St. Vincent Street, Glasgow, chartered accountant; Mrs. J. Cassells, 68, Glencairn Drive, Pollokshields; J. Taylor, 14, Regent Park Terrace, Glasgow, superintendent; and J. Livingston, 168, St. Vincent Street, Glasgow, clerk. The number of directors is not to be more than three; the first is Robert Livingston; qualification, 50 shares. Registered office, 168A, St. Vincent Street, Glasgow.

Invention Proprietary Syndicate, Limited (73,253).—This company was registered on March 27th, with a capital of £1,000 in £1 shares, to acquire, subject to an agreement between A. T. M. Johnson and E. J. Richardson, all the interest of the said A. T. M. Johnson and G. Guyott in the British Patent, dated May 1st, 1902, and numbered 8,067, for improvements in harmonic telegraphy; also in an invention for improvements in the means of transmitting and receiving musical sounds electrically, applicable to harmonic telegraphy or telephony; also in an invention for improvements in means of and apparatus for electrically transmitting and receiving messages; also the interest of the said A. T. M. Johnson in certain patents to be granted to him and the said E. J. Richardson or either of them in France, Belgium, Germany, Italy, Austria, Hungary, Switzerland, and the U.S.A., Canada, Australia, Cape Colony, Natal, Rhodesia, and the Transvaal; and to construct, maintain and deal in and with land and submarine telegraphs and telephones, and in particular wireless, secret and harmonic telegraphs and telephones in which the methods of syntonised synchronism are employed, and other electrical or other contrivances. The first subscribers (each with one share) are:—G. Guyott, 19, Calabria Road, Highbury, N., wine and spirit merchant; W. A. Shelvey, 39, High Holborn, W.C., wine merchant's manager; J. A. Robertson, 28—9, St. Swithin's Lane, E.C., accountant; H. Duncan, 1, St. Helen's Place, E.C., gentleman; T. R. Lewis, 52, Aislibei Road, Lewisham, surveyor; A. T. M. Johnson, 108, Calabria Road, Highbury, N., retired; and A. Angold, 19, John Street, Bedford Row, W.C., gentleman. No initial public issue. Registered without articles of association. Registered office, 11, John Street, Bedford Row, W.C.

Shanghai Electric Power and Traction Syndicate, Limited (73,321).—This company was registered on April 4th, with a capital of £6,000 in £1 shares, to construct or acquire, maintain and work by horse, electrical, steam, or other power, tramways, railways, boats, and means of communication in Shanghai or elsewhere in Asia, to acquire running powers or other rights, and to carry on the business of railway, tramway, omnibus, van, and boat proprietors, carriers, generators, accumulators, and distributors of electrical energy, electricians, electrical engineers, suppliers of electric light, &c. The first subscribers (each with one share) are:—H. W. Perry, 32, Church Hill Road, Walthamstow, gentleman; A. C. Batt, 9, Fairmount Road, Brixton Hill, S.W., gentleman; H. A. Neild, 3, Brunswick Square, W.C., gentleman; J. H. Blackmore, 21, Sheen Grove, Richmond Grove, Barnsbury, N., clerk; W. Gilbert, 30, Carlton Road, Putney, clerk; H. F. Weston, 60, Holmwood Gardens, Brixton Hill, S.W., gentleman; and A. B. Johnson, 66, Limes Grove, Lewisham, S.E., gentleman. No initial public issue. The number of directors is not to be less than three nor more than 10. The subscribers are to appoint the first; remuneration as fixed by the company.

Charing Cross Syndicate, Limited (73,293).—This company was registered on April 3rd, with a capital of £10,000 in £1 shares, to apply for, promote, or obtain Acts of Parliament, orders, and authorities relating to the incorporation of a company or companies for the construction of underground or overground railways or tramways (to be worked by electricity or otherwise), light railways, and other projects and undertakings, to adopt an agreement with the London and Provincial Electric Construction Company, Limited, to construct, equip, and work by steam, electricity, cable, or other mechanical power any railways and tramways, and to manufacture and deal in omnibuses, motor cars, carriages, electrical and other appliances, &c. The first subscribers (each with one share) are:—A. R. Davy, Combe Edge, Bagshot, gentleman; Col. N. L. Pearce, York Mansions, Westminster; C. B. Marshall, York Mansions, Westminster, solicitor; F. A. Leonhardt, Alton Lodge, Carshalton, Parliamentary agent; P. W. Meik, 16, Victoria Street, S.W., civil engineer; C. S. Meik, 16, Victoria Street, S.W., civil engineer; and R. E. Middleton, 17, Victoria Street, S.W., civil engineer. No initial public issue. The number of directors is not to be less than three nor more than nine; the subscribers are to appoint the first; qualification, £100; remuneration as fixed by the company. Registered office, York Mansions, 87, York Street, Westminster, S.W.

Underground Electric Railways Company of London, Ltd. (73,476).—This company was registered on April 9th, with a capital of £5,000,000 in £10 shares, to acquire the undertaking of the Metropolitan District Electric Traction Company, Limited, to promote the adoption of electric traction for railways, light railways, and tramways in the United Kingdom; to construct and maintain works, buildings, rolling stock, and conveniences for providing, working, and maintaining electric traction, and particularly works for the generation, distribution, accumulation, application, and use of electric energy; to acquire any railways, light railways and tramways, or rights in relation thereto, to equip the same with electric or other traction, and to carry on the business of electrical, mechanical, and general engineers; suppliers of electricity for light, heat, motive power, and telegraphic, telephonic, and other purposes; company promoters, financiers, guarantors, contractors, &c. The first subscribers (each with one share) are:—E. S. Speyer, 7, Lothbury, E.C., banker; W. H. Brown, 7, Lothbury, E.C., banker; A. N. Smith, 27, Carlton Hill, N.W., clerk; H. G. Leith, 35, Hans Road, S.W., clerk; C. T. Yerkes, Hamilton House, Victoria Embankment, W.C., gentleman; W. E. Mandelick, Hamilton House, Victoria Embankment, W.C., gentleman; and A. J. Kent, 8, Cross Road, South Wimbledon, accountant. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers, subject to the right during the first 10 years of Speyer Brothers, of London, Speyer & Co., of New York, and the Old Colony Trust Company, of Bolton, U.S.A., whilst they or any of them remain members of the company, to nominate a majority of the directors for the time being; qualification, £1,000; remuneration as fixed by the company.

F. A. Glover & Co., Limited (73,356).—This company was registered on April 8th, with a capital of £10,000 in £1 shares, to adopt an agreement with F. A. Glover, for the acquisition of the business of an electrical and general engineer carried on by the said F. A. Glover as "F. A. Glover & Co.," and to carry on the business of electrical, mechanical, hydraulic and general engineers, &c. The first subscribers (each with one share) are:—F. A. Glover, 97, Queen Victoria Street, E.C., electrical engineer; A. Glover, Elmstree, Forest Hill, S.E., engineer; R. H. Hayne, 97, Queen Victoria Street, E.C., electrical engineer; T. Jacob, 97, Queen Victoria Street, E.C., electrical engineer; S. W. Duttson, 15, Fish Street Hill, E.C., merchant; H. L. Duttson, 15, Fish Street Hill, E.C., merchant; and H. M. Armitage, 97, Queen Victoria Street, E.C., clerk. No initial public issue. The number of directors is not to be less than two, nor more than five: the first are A. Glover, F. A. Glover and R. H. Hayne; qualification, £50. Registered office, 97, Queen Victoria Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Westminster Electric Supply Corporation, Limited (27,061).—This company's annual return was filed on March 19th, when 109,520 ordinary and 28,141 preference shares were taken up out of a nominal capital of £800,000 in 110,000 ordinary and 50,000 preference shares of £5 each (increased from £550,000 to £800,000 in December, 1901). £5 per share has been called up on the ordinary and £2 10s. on the preference shares, resulting in the receipt of £617,052 10s., in addition to £28,540 paid in advance. Mortgages and charges—£250,000.

Peto & Radford, Limited (51,387)—This company's annual return was filed on March 20th, when 6,500 shares were taken up out of a nominal capital of £10,000 in 10,000 shares of £1 each. £1 per share has been called up on 2,000, resulting in the receipt of £2,000. £4,500 is considered as paid. No mortgages or charges.

Morley Electrical Engineering Company, Limited (52,358).—This company's annual return was filed on March 10th, when 1,524 shares were taken up out of a nominal capital of £5,000 in 5,000 shares of £1 each. £1 has been called up on each of 504 shares, resulting in the receipt of £504. £1,020 is considered as paid. Mortgages and charges—£1,000.

CITY NOTES.

Brush Electrical Engineering Company.

Lord Vaux of Harrowden presided on 10th inst. at Winchester House over the thirteenth general meeting of the above company, and in moving the adoption of the report, said it was with great regret that they did not find themselves in the position of declaring a dividend. They were aware that in consequence of the pressure of other business, Mr. J. B. Braithwaite, jun., had resigned the chairmanship of the company, notwithstanding his long connection with it, and there was no doubt that the company owed a great deal to the zeal and energy which Mr. Braithwaite had devoted to its interests. They had to deplore the loss of another director, the late Mr. Slater Lewis, who, unfortunately, died before he was able to complete the organisation of the works at Loughborough—a reorganisation of which the necessity was so evident to all of them. Notwithstanding the unfortunate death of Mr. Slater Lewis, the Brush Company had continued to devote anxious attention to this important work, the fruits of which he trusted they would see in greatly improved results. He was happy to inform them that Mr. W. L. Madgen had been elected to a seat on the board, and that gentleman had now for some weeks been actively engaged on the work of the reorganisation of the Loughborough works. Reductions and changes had been made, which already had certainly effected economies. They would observe in the profit and loss account that there was a gross profit of £61,054 8s. 10d., which was within £700 of the figure at which it stood in the previous year. As a matter of fact, if they analysed the items, this figure was really better than that of last year. In the first place, £3,000 less was brought into the account than in the previous year—only £1,500 was brought forward that year, in place of £5,000 brought forward in the previous year. Then the gross profit on trading was £52,142, which was £2,000 more than for the 12 months ending 1900. With regard to their financial profits—he meant those which were obtained from interest on securities and sales of securities—the items were just £800 more than in the preceding year. Now they were £7,303 15s. 11d., and in the previous year they were £6,496 9s. 6d. It would thus be seen that the falling off in the gross profit was entirely due to the smaller amount brought forward. To pursue the subject further, there were still one or two items which could, had they been brought into this account, have given it a better complexion. There was a matter of £1,000 or £1,200 profit on the Australian branch for the year, which, although actually earned, had not been taken credit for, as the certified accounts were not received in time to be included. They had also made certain additions to holdings in other undertakings, and although the undertakings were all of a sound and progressive character, yet it so happened that that year in one of the most important of them the dividend had not been declared, and consequently it would have to be included in the next year's accounts. Meanwhile about £60,000 had practically brought no interest into the balance-sheet, although it was really earning money, and was likely to give a good profit next year. They were in the position that their capital account was £117,000 higher than last year, and the interest on a large portion of this money, although accruing, was not yet in their pockets. There were various other items in the profit and loss account to which he need not draw their attention, but there were one or two items, which he would call abnormal items. The damage caused by the flood 15 or 16 months ago cost them £888 for repairs, and that was an item they trusted they would not have again. There was also an item of £500 paid to a director for special services rendered, which was really the allowance paid by the purchasers of an undertaking sold by them at a substantial profit to a director, who was also a director of the Brush Company, for past services, and as compensation for loss of office. Strictly speaking, the amount should have been paid direct by the purchaser, and should not have appeared in the accounts, but inasmuch as the money was first received by the Brush Company, it was necessary to refer to it in the accounts. They had also paid £407, being the remainder of cost of redeeming £16,290 second debenture stock, and that would not occur again. Further, they had written off £2,593, being a portion of the expenses of the new share issue. The board proposed to write off the remainder of these expenses, which came to about £4,000, in the next two years. They had carried £6,500 to depreciation reserve fund, as against £5,000 last year, and the fund now stood at £25,606, which the board felt was by no means excessive, for, in these days of severe competition, machinery, and especially machinery of engineering works, quickly became obsolete. If they were to compete successfully, they must have the newest and best, and must be prepared from time to time to throw out of use machines which, although not worn out, were unable to turn out work as economically as new and better machines in the shops of their competitors. The board would like to see the reserve fund substantially increased. Coming to the general reserve fund, they had placed £8,500 to that, and he might tell them that that question was receiving the most anxious and exhaustive consideration at their hands. The prospects of the Brush Company were good. Closely associated as they were with some of the most prominent electrical undertakings in the country, the demand for their manufactures must be constant and increasing, and they hoped by exercising strict economy, and employing the best men available, they would be able to earn a full dividend on the preference shares and a fair dividend on the ordinary shares. But the board were most anxious not to inaugurate their policy by dividing profits up to the hilt. They possessed no general reserve fund, although in the articles of association it was clearly contemplated that such a fund should exist. It was of permanent importance that the nucleus of such a fund should be formed at once without delay, and the board earnestly and confidently trusted the shareholders would give them their full support. The attention of all must have been drawn to the auditors' certificate with regard to the items of patents and goodwill which had stood at £181,397 8s. 9d. for the last five years. The board had given, and were giving, the most earnest consideration to these items. They were quite as much alive as the auditors to the importance of that figure in the balance-sheet, but they were not yet prepared to make any recommendation. It was, however, in common with other matters affecting the prosperity of the company receiving their careful attention. On the whole the prospects of the electrical manufacturing industry were good. There were many tramways and tubes in contemplation or under construction, and one of the big railway companies was applying for leave to change from steam to electricity. The probability was that the demand for all electrical equipment would go on increasing, with the result that they would find their works, which were in good working order, fully occupied in meeting the demand.

Mr. J. S. Raworth, in seconding the motion, said that having been associated with the company for 16 years as chief engineer and member of the board, he endorsed every word uttered by the chairman as to the present strong position of the company and the prospects of future success.

Mr. Knight said he would be glad to know when the position of

the preference shareholders was going to be considered by the board. He pointed out that in the past, owing to the declaration of interim dividends on the ordinary shares, it had been found at the end of the year that there was not sufficient to pay the preference shareholders in full, and he suggested that the board should consider the question of making the preference shares cumulative.

Mr. Sisley remarked that £80,000 had been expended in the last two years on buildings and plant, and he would like to know where the profit they were told would result from that expenditure was. It either seemed that the expenditure was unnecessary, or else the management was unable to produce the profit that was desired.

Mr. Conway alluded to the auditors' remarks on the figure of £181,000 being placed on goodwill and patents. It seemed to him rather vague, and he asked what was the estimate the board really placed on the items. The value might be nothing, and he did not see why it should come into the balance-sheet at all.

Mr. Roland said that, having been a shareholder six or seven years, he could not help viewing the present position with dismay. He would like to know the real relationship to the British Electric Traction Company, for in his own mind he could not help associating the present position of affairs with such relationship, for they seemed to be going down year after year. He would like to know if the Brush Company had been underwriting shares for the British Electric Traction Company; and if they had, he should object to it. He did not grumble at the figures as they were presented, because he was not an expert; but he looked at the matter from the ordinary point of view of an investor who, putting money into a go-ahead industry like the electrical industry, naturally expected to get bigger dividends as years went on, instead of getting nothing.

Mr. W. Bowen remarked that he would like to know if American methods were being introduced, and pointed out the fluctuations in the Stock Exchange quotations of the company's shares, prior to the publication of the report, which certainly showed that there was a leakage of information somewhere. With respect to the auditors' certificate, it seemed that these gentlemen told them something which they had known for five years, although now they were forced to bring it forward owing to the passing of a Bill by the present much-maligned Government. It was amusing to notice the way in which the goodwill and patents were estimated at £181,397 8s. 9d., and he would like to know if the goodwill of the company was represented by the 8s. 9d. Then the shares and debentures were valued down to 16s. 10d., but the auditors said they did not know what they were worth. He suggested that there should be clean finance, and that a lot should be knocked off the patents, and the shares and debentures should be put down for what they were actually worth.

Mr. Emile Garcke said he was the managing director of the British Electric Traction Company, which had been referred to, and some of them would recollect that 10 years ago he was the manager of the Brush Company. He regretted that the company was not now in the position in which he left it. He believed, however, the company had something good to look forward to. The company was a very old one, and was started in the very early days when electricity was in its infancy, and he remembered that during the eight years that he had the management of it, it was very difficult to keep it alive at all. All the other electrical companies went into liquidation, and the Brush Company alone survived. He thought, however, that the time was undoubtedly coming when their hopes would be realised. He represented companies which had an interest of something like £100,000 in the company, and spoke with a sense of considerable responsibility when he said that he was thoroughly satisfied with the report, and he sincerely hoped the meeting would give the board unanimous support, because they had had the courage to come before them with an unfavourable report; it was most important that bodies of shareholders should not discourage boards of directors from coming before them with a plain unvarnished statement with regard to the position. He thought that in itself was the best augury of the success they would achieve in the future. He felt thoroughly satisfied with the way the directors had put the position before them rather than if they had squeezed every penny from the revenue account to pay additional dividends. The balance-sheet showed that last year they had a considerable amount of liabilities. During the year additional capital had been raised to remove these liabilities and put the company upon a stronger basis, and by reason of that additional capital they could not pay the same dividend as before out of approximately the same profits. What was the position now? They had practically exhausted every means of raising fresh capital. They had first and second mortgage debentures, and they had practically no other means of raising additional capital, and he asked if it was prudent under these circumstances to divide up to the hilt and leave the company without the means of carrying on its business. One gentleman had asked what the relations were between the company and the British Electric Traction Company. When he became associated with the British Electric Traction Company, who were large buyers of apparatus, he naturally felt an interest in the old company, and whenever it could be done without any prejudice to the interests of his shareholders, he turned orders in the direction of the Brush Company. It was his desire to continue to do so. Those relations led the directors of the British Traction Company, who were large buyers, to see if it was not possible to obtain an interest in the Brush Company, and the result was that shares were exchanged at the then market price, and in pursuance of the same view the British Electric Traction Company subsequently underwrote £50,000 capital for the Brush Company at par. He confessed that he would probably have some difficulty in justifying that transaction to the shareholders of the British Electric Traction Company, but his company had increased their holding in the full confidence that in time it would prove a good investment. With regard to the question asked as to the Brush Company having underwritten shares in companies promoted by the British Electric Traction Company, he knew of nothing of the kind having been done; but it had been done in the case of one company in which both the British Electric Traction Company and the Brush Company were jointly interested, and in this case the company was a large buyer. As to the questions asked regarding goodwill, his feeling was that accountants and auditors would differ very much as to the correct way of stating that item in the account, and, after all, the strict business view was that the goodwill of a business was worth what that business would yield. There were many companies with a goodwill largely in excess of that of the Brush Company, but it was not written down because the earnings of the company were sufficient to pay a good dividend upon the capital represented by that goodwill, and so long as the capital was remunerative there was no harm whatever in allowing it to stand at the figure it did. It was only when an undertaking ceased to make a fair return that the question of goodwill arose, and it was in that sense he took it that the auditors had referred to it now, although apparently they had not done so on former occasions. He thought it was too early for the present board to form any opinion on that matter, and they ought not to be asked to commit themselves to any policy with regard to it.

After several other shareholders had addressed the meeting, the Chairman said that Mr. Garcke had answered many of the points raised, and he need not refer to them. It would be impossible to make the preference shares cumulative without altering the articles of association. With regard to the new buildings and plant, they had already produced better results, and hoped to produce better still. It was impossible to manufacture economically unless they had the best plant, and if they could not do that, they could not compete against others. Reference had been made to a matter the board deeply deplored—the selling of shares on the Stock Exchange. The board were utterly unaware that anything of the sort was being done, and they had no means of knowing who did it. Very earnest and careful consideration had to be given to several questions, and the probable fact was, that people who were accustomed to see the report issued earlier became suspicious of the delay, and thought there was something a little unfavourable. Had any gentleman anything definite to tell them?

After further remarks, Mr. Conway wished to know if any fresh shares had been issued since the issue of preference and ordinary shares was made to the shareholders share for share.

The Chairman said that since the issue referred to by Mr. Conway fresh capital was necessary, and the old board came to the decision that the best arrangement which could be made was to get the British Electric Traction Company to take the whole of the remainder of the preference shares on condition that they took 25,000 ordinary shares of £2 at par. At that time the ordinary shares stood at from $1\frac{3}{4}$ to $1\frac{7}{8}$, and although he and the majority of the present board had nothing to do with the arrangement, he thought the old board had done the best for the company, and he did not see how the money could have been raised in any other way. He certainly could not agree to disclose the volume of trade, as it would be a suicidal policy. As to the investments they could not get at the value, because they were not quoted. They had realised one undertaking in the past year at a substantial profit, and they hoped that year to do the same. It would be no good for them to depreciate the value of the securities in the eyes of the public. The board did not defend the mixing up of the goodwill and patents, and the matter now had their serious consideration.

The report was then put and carried with four dissentients.

Calcutta Electric Supply Corporation.

The directors' report to be presented at the annual meeting at Winchester House, on Thursday, May 1st, at 2 p.m., reads as follows:—

"The directors beg to submit the annual statement of accounts and balance-sheet of the company, for the year ending December 31st, 1901, and have pleasure in again congratulating the shareholders on the successful result of the year's working. The number or units of electrical energy sold during the year were 962,958, compared with 412,950 for the preceding year. The gross revenue from all sources amounted to £23,248 19s. 9d., compared with £11,147 15s. 8d., the working costs were £14,602 18s. 2d., compared with £8,252 17s. 4d., and the result of the year's operations was a net profit of £8,646 1s. 7d., compared with £2,894 18s. 4d. Exchange is calculated at 1s. 4d. per rupee. At the general meeting last year the shareholders adopted the suggestion of the board to deduct £2,500 from the profit and loss account as a provision for repairs and renewals, and the directors have this year deducted £5,000 from the year's account for the same purpose. The amount expended during the year in repairs and renewals and in the purchase of spare parts was £1,900 10s. 8d., the whole of which has been debited to the renewal fund account, leaving a balance carried forward of £5,599 9s. 4d. To the net profit of £8,646 1s. 7d. has to be added £219 1s. brought forward from last year, and £151 14s. 1d. interest on deposits at bankers, making a total of £9,016 16s. 8d., and after deducting interim dividend paid on November 4th last, there remains a balance of £5,822 6s. 3d. available for distribution. The directors propose to pay a final dividend for the half-year at the rate of 7 per cent. per annum on the paid-up share capital, making, with the interim dividend, 6 per cent. for the year, and to carry the balance, £392 9s. 2d. forward. During the past year the board have issued 10,000 additional shares at the price of £6 per share, the premium on the issue, £10,000, being placed to the

reserve fund, which now amounts to £15,000. The board have invested £9,900 of this amount partly in consols and partly in railway preference shares. The capital expenditure during the year amounted to £62,372 18s. 8d., the largest proportion, £37,322, was in mains, £12,067 in machinery and tools, and £4,038 on buildings. The total amount of expenditure at December 31st last was £180,639 3s. 4d. The directors have taken advantage of the presence of Mr. A. H. Preece, M.Inst.E.E. (who was visiting India), to inspect and report on the company's installation, and his report is satisfactory. It is proposed, during the current year, to carry out large extensions to the mains which will involve considerable additional outlay. The new station in the Alipore district has been erected, and the equipment is nearly completed. The station was opened onMarch 1st. Application has been made to the Government of Bengal for a license to supply the Howrah district, which is on the side of the river, and as the consent of the municipality has been obtained, no doubt the Government license will be granted in due course. Owing to the increasingly heavy load in the north of the city it is in contemplation to erect a third generating station at Cossipore. During the year 1901, 292 additional houses have been connected to the mains, the total number of consumers being now 880, and the equivalent of 8-c.p. lamps at December 31st, 58,284 as compared with 28,748 at the end of the previous 12 months. The running of the station has been good. There have been some breakdowns on the mains which have given the directors much concern, but it is confidently expected that with a few alterations in matters of detail the difficulties will shortly be overcome. In accordance with the articles of association, Mr. P. V. Luke, C.I.E., retires from the board of directors by rotation, and, being eligible, offers himself for re-election. The auditors in London, Messrs. J. H. Duncan & Co., chartered accountants, and in Calcutta, Messrs. Lovelock & Lewis, also offer themselves for re-election."

Ferranti, Limited.

The first general meeting of this company was held at the offices on April 3rd, Mr. S. Z. de Ferranti presiding.

The Chairman said that the report showed that only £1,700 was to be paid to the ordinary shareholders, but this must be noted in conjunction with the fact that £8,215 was paid to the old company as interest on the purchase price. Of the sum paid in interest, over £4,000 went to the ordinary shareholders of the old company, and that sum, together with the £1,784 paid to the ordinary shareholders of the new company, makes in all an amount equal to 6 per cent. paid on the ordinary shares of the company for the year. If it had been their policy, which it was not, to pay out all the moneys available, they could have made this either 10 or 11 per cent., for there was a balance of profit of over £5,000 partly carried to reserve account, and partly carried forward. It was the intention of the directors to deal with the accounts in such a way that they might consider themselves always on the safe side, and in paying to the ordinary shareholders an amount equal to 6 per cent. they thought they were perfectly safe to continue to pay this, and they had reason to hope that they would increase it. Another strong feature in the report was the very large proportion of revenue devoted to the upkeep and depreciation of plant. They had written down the value of the plant to the extent of £5,800 while spending £3,700 in repairing and renewing it, and during the past year had actually reconstructed and modernised a number of their machine tools. With regard to capital, the prospectus was issued in July, hoping to obtain £120,000 in preference shares. They only got £60,000 subscribed, but the whole sum asked for could have been profitably employed in the business. He was assured, however, that, in a certain measure, they might consider themselves fortunate in having obtained the money they did, the very depressed state of the money market generally at that time making it extremely difficult to raise money. However, with the satisfactory accounts, and with the prospects which they had, and the orders at present in hand, there should be very little difficulty in getting the capital which they certainly felt the want of, and which should enable them to go ahead and expand. That there was room for, and a serious demand for, this expansion he was convinced. Great resources are now being utilised to develop the electrical industry in this country, and a great increase of production will result therefrom; but he was satisfied that the increase of electrical enterprise would be so considerable in the near future, that the supply would not do more than meet the demand. The work done by the company was nearly all of a special nature, and on the specialities that they were dealing with they could more than hold their own in the face of competition. They had requested Mr. Scott Lings—and he had consented—to join the board. That gentleman helped in the reconstruction of the company, and to have him on the board would be a source of strength to the company financially. In order to make room for Mr. Lings, the number of directors being limited to five, and also for some further strengthening which they deemed advisable, and for which they expected the opportunity soon to arise, it was necessary for two of the present directors, Messrs. Day and Del Rivo, to retire. They were not in any way losing the benefit of their services, as they would retain their respective positions in the company. In view of this alteration in the directorate, which had hitherto been not only a board of directors, but in a minor degree a committee of management, they felt it a necessity that the central control of the business should be vested in one man, subservient only to himself (Mr. Ferranti) as the managing director of the company. It had therefore been decided to appoint Mr. A. B. Anderson, who was at present one of their directors, and who had been for the past 10 years a valuable servant of the company, to the position of assistant managing director.

The report and balance-sheet were unanimously adopted.

Babcock and Wilcox, Limited.

At the meeting held at Cannon Street Hotel on Tuesday, Mr. John Dewrance said that the amount of profit was very similar to that of the previous year. Last year was one of considerable anxiety, and he thought that the staff had done extremely well. They looked forward to the present being a better year. Their order sheet was very satisfactory, and they saw nothing but the promise of progress. A great deal had been done to improve the premises and plant at Renfrew. The electrical driving installation had been set to work, and great care had been given to improving the method of manufacture.

Dividends were declared for the half-year ended December 31st last as follows:—At the rate of 3 per cent. on the preference shares, and at the rate of 9 per cent. on the ordinary shares; £45,000 was transferred to the reserve fund, £25,000 to the dividend equalisation fund, and a balance of £17,446 carried forward.

Guildford Electricity Supply Company.

The annual meeting was recently held at Guildford, Dr. F. R. Russell presiding.

The report for the year 1901 showed that not only had there been a gain in gross revenue of £515, but a decrease of no less than £377 in expenditure, notwithstanding an increased output of over 20 per cent. The total gross profit was £960 19s. 3d., which was equivalent to 4 per cent. on the total capital of the company, including loans in use during the year. Considerable improvements had been made to the machinery during the year, chiefly in the direction of fuel-saving apparatus. All the temporary sheds had now been removed, and substantial and well-lighted buildings erected, which would hold all the machinery the company was likely to want for some years to come. The revenue account showed expenditure as follows:—Generation of electricity, £1,134 4s. 2d. (including fuel £814 7s. 9d., wages and gratuities at generating station £175 3s., repairs and maintenance £102 1s. 9d.); distribution of electricity, £13 9s. 1d.; rates and taxes, £87 5s. 10d.; management expenses, £258 6s. 6d. (salaries of managing engineers, secretary and accountants £200 15s.); law expenses, £23 15s. 4d.; depreciation, £119 8s. 7d.; insurances, £17 6s. 8d.; total expenditure, £1,653 16s. 2d. The receipts included:—Sale of current per meter at 7d. per B.T.U., less discounts, £2,192 8s.; rental of meters and sale and repair of lamps and other apparatus, £188 1s.; rents, transfer fees and miscellaneous, £114 17s. 10d.; total receipts, £2,495 6s. 10d.; The balance carried to net revenue account was £841 6s. 10d., which was allotted at follows:—To balance from last account £183 10s. 2d.; interest on debentures accrued due to date, £286 13s. 5d.; ditto on temporary loans, £264 2s. 11d.; balance carried to balance-sheet, £107 4s. 2d. The depreciation fund account, including the £119 8s. 7d. brought from revenue account, amounted to £400.

The Chairman remarked that there was an improvement both in the amount received for current and in the expenses. The coal bill had diminished both from the coal being cheaper and also because of the very excellent cells they had got in, which had been a great saving to the company. They had now also put in condensers and other coal-saving machinery, which he hoped would enable them still further to reduce the cost. After a great deal of discussion the board had decided not to raise the price of the current this year. They felt that it was necessary now that a dividend should be paid on the ordinary shares. They had had to raise capital by means of debentures at a very high rate of interest, and it had, therefore, up to the present been impossible. He proposed that the accounts be adopted.

Mr. Asher seconded the motion.

Strong criticisms of the affairs of the company were passed by Mr. L. Ellis, Mr. W. R. Emery and Mr. H. Fentum Phillips, and these were replied to by the chairman and by the managing engineer (Mr. J. M. V. Money-Kent).

The report was adopted.

Buenos Ayres and Belgrano Electric Tramways Company.

The report for 1901, to be submitted at the meeting on the 17th inst., states that the total receipts amounted to £147,212, and total expenditure to £87,712, leaving a balance of £59,500. This balance, with the amount brought forward from last year (£1,474), has been carried to net revenue account. After providing for debenture stock and other interest, and placing £3,000 to the credit of renewal funds, and setting aside £2,500 as a provision for pending compensation cases, there remains a balance of £31,851 at the credit of net revenue account. An interim dividend of 3s. per share on the "A" preference shares was paid in October last, and the directors now recommend the payment of a further 3s. per share, making the full dividend of 6 per cent. on these shares for 1901. An interim dividend of 3s. per share on the "B" preference shares was also paid in October last, and the directors now recommend the payment of the balance of 3s. per share, making the full dividend of 6 per cent. on these shares for 1901, together with a further dividend of 7 per cent., or 7s. per share, on account of arrears of dividends on these shares. Deducting these dividends now recommended, amounting altogether to 10s. per share, or 10 per cent., the arrears on the "B" preference shares will amount to 7s. 6d. per share, or 7½ per cent. The foregoing dividends on both classes of preference shares will absorb £19,750, leaving a balance of £1,976 to be carried forward to next account.

Company, but his company had increased their holding in the last

Stock Exchange Notices. — The Committee has appointed a special settling day as under:—Tuesday, April 29th. Charing Cross and Strand Electricity Supply Corporation, Limited.—Further issue of 20,000 ordinary shares of £5 each, fully paid, Nos. 50,001 to 70,000; and 20,000 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 50,001 to 70,000. Electric Lighting and Traction Company, of Australia, Limited.—£75,000 5 per cent. debenture stock; and a further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 20,001 to 30,000, and has ordered the same to be quoted in the Official List, also City and South London Railway Company.—£150,000 5 per cent. perpetual preference stock, 1901.

Indo-European Telegraph Company.—The board, after adding £5,000 to the reserve fund, recommend the payment of a dividend for the six months ended December 31st, 1901, of 17s. 6d. per share, making with the interim dividend already paid 6 per cent., and a bonus of 20s. per share, both free of income-tax, in all 10 per cent. for the year. The dividend and bonus will be payable on and after May 1st next.

Globe Telegraph and Trust Company.—A quarterly interim dividend, payable on and after April 30th next, of 3s. per share on the preference shares, less income-tax, and of 2s. 6d. per share on the ordinary shares. The transfer books will be closed from 22nd to 29th inst.

South London Electric Supply Corporation.—The poll took place on Tuesday on the question of the election of Mr. Atherton to a seat on the board, with the result, as we are informed, that the election of that gentleman was passed by a majority of 14,072 votes.

British Insulated Wire Company.—The report to be submitted at the meeting on the 23rd inst., states that the gross profits for the year amount to £106,427, to which must be added the balance brought forward, making a total of £113,191. Negotiations have been in progress for some time past for a union of interests with a strong and successful company, carrying on a business which is, in the opinion of the directors, well suited for working in unison with this company's business, to the great advantage of both.

The directors have recommended a dividend at the rate of 10 per cent. per annum for the past half-year on the ordinary shares, making 10 per cent. for the year.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending April 11th **were £609; corresponding week last year, £921; decrease, £312. Total to date, £9,318; corresponding period last year, £8,009; increase, £1,309. Miles of track open, 10¾.**

Blackpool and Fleetwood Tramways.—The receipts for the week ending April 12th **were £254; corresponding week last year, £706; decrease, £452. Total receipts to date, £3,323; corresponding period last year, £2,973; increase, £350.**

Bristol Tramways and Carriage Company.—The receipts for the week ending April 11th **were £4,042; corresponding period** (Easter week) **last year, £5,050; decrease, £1,008.**

Central London Railway.—The receipts for the week ending April 12th **were £6,720; corresponding week last year, £6,652; increase, £68. Total receipts to date, £99,195; corresponding period last year, £91,541; increase, £7,654. Miles open, 6.**

City and South London Railway.—The receipts for the week ending April 13th **were £2,931; corresponding week last year, £1,953; increase, £978. Total receipts to date (15 weeks), £44,733; corresponding period last year, £30,190; increase, £14,543. Miles open, 6¼; last year, 4¾.**

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending April 4th:—

Company.	Amount £	Comparison with corresponding week of last year. + £	Comparison with corresponding week of last year. — £	No. of weeks.	Aggregate. Amount. £	Aggregate. Inc. or Dec. + £	Aggregate. Inc. or Dec. — £
Devonport†	415	—	—	13¼	5,151	—	—
Dudley-Stourbridge	1,134	606	—	13½	8,765	2,087	—
Gateshead†	755	—	—	13½	8,506	—	—
Greenock-Pt. Glasgow	541	351	—	13½	5,064	2,795	—
Hartlepool	350	140	—	13½	2,483	171	—
Kidderminster	191	99	—	13½	1,315	214	—
Merthyr*	303	—	—	13½	2,644	—	—
Middleton†	405	—	—	13½	524	—	—
Oldham-Ashton	637	106	—	13½	6,984	147	—
Poole†	352	—	—	13½	2,632	—	—
Potteries	1,636	267	—	13½	18,344	920	—
Southport	354	222	—	13½	1,578	574	—
South Staffordshire‡	1,096	428	—	13½	9,828	946	—
Swansea	566	164	—	13½	5,530	655	—
Taunton*	91	—	—	13½	737	—	—
Tynemouth‡	360	138	—	13½	2,629	221	—
Wolverhampton Dist.	254	207	—	13½	1,778	1,174	—

* Not in operation last year. † Partly steam.
‡ Comparison from March 18th only.

Dover Corporation Tramways. — **The receipts for the week ending** April 12th **were £175 15s. 7½d.; corresponding week last year, £252 9s. 11½d.; decrease, £76 14s. 4d. Total to date, £2,611 10s. 6d.; corresponding period last year, £2,472 2s. 2d.; increase. £139 8s. 4d. Miles of track open, 8. Car miles run, 1902, 5,132; 1901, 5,097. Number of cars, 1902, 12; 1901, 11.**

Dublin United Tramways Company.—The receipts for the week ending April 11th **were as follows:—D.U.T. Co., £3,484 9s. 8d.; D.S.D. Co. £760 6s. 11d.; total, £4,244 16s. 7d.; corresponding week last year—D.U.T. Co., £3,824 11s. 4d.; D.S.D. Co., £1,213 2s. 10d.; total, £5,037 14s. 2d. (Easter week and Spring Show, 1901); decrease. £792 17s. 7d.; aggregate to date, £58,884 14s. 2d.; last year, £55,780 6s. 7d.; increase, £3,104 8s. 1d. Mileage worked, 46.**

Glasgow Tramways.—For week ending April 12th, 1902, £10,995 17s. 3d., compared with £8,790 6s. 6d. for the corresponding week last year.

Liverpool Overhead Railway. — The receipts for the week ending April 13th **were £1,507: corresponding week last year, £1,871; decrease, £364. Total to date £20,996: corresponding period last year, £22,684; decrease, £1,688. Miles open, 6 miles 57 chains.**

STOCKS AND SHARES.

Wednesday Evening.

Budget Day passed and gone, the Stock Exchange knows the financial worst that will have to be faced for at least six months to come. "House" opinion puts Sir Michael's effort down as essentially commonplace, and almost the only stock to be materially affected is Consols, which have fallen on the coming of the 32 million pounds loan.

The Home Railway Market, however, has suddenly developed strength, and its unexpected cheeriness is leading to inquiries for electrical stocks, Central London issues being the best feature. Supply descriptions are better upon influential buying. In the Telegraph section another wave of depression has put in an appearance, and amongst Miscellaneous varieties, a sharp fall has silhouetted Electric Constructions against an otherwise colourless market.

We have on several occasions referred to the advent of a large Welsh power company, and the skeleton prospectus shows that this South Wales Electrical Power Distribution Company, Limited, has a share capital of £750,000 divided into 75,000 shares of £10 each, with power to issue another ¾ million Debenture stock. Its objects are tersely summed up in the opening words of the prospectus: "This company was incorporated by Act of Parliament for the purpose of providing and distributing electric energy in the County of Glamorgan and all that portion of the County of Monmouth lying west of the River Usk, this comprising the noted coalfield of South Wales." The prospectus goes on to state that the above-mentioned district has an area of 1,034 sq. miles, a population of over a million people, besides some 2,400 collieries and factories. Allowing 5 per cent. interest on the Debenture stock, a profit of 8 per cent. is estimated on the shares which it is proposed to issue. Of course, the proposition may undergo alteration before it is offered to the public, and any present comment would obviously be premature.

Electrical supply descriptions are a good market, and a lot of business is doing in shares of those companies working within the Metropolitan area. Westminsters, Bromptons, "Jimmies" and Metropolitans all show advances. Edmundson's are ¼ up, and South Londons have risen to 3. County Ordinary and Preference, although displaying no quotable change in price, are freely changing hands. The only decline in the list, curiously enough, is in Metropolitan 3½ per cent. Debenture, which has dropped a point. Of course the demand for Electric Supply shares is attributed to June prospects. Under the circumstances it is somewhat remarkable that Electric Constructions should be so flat, the price having slumped from 1¾ to 25s. sellers. A bad report is expected, and after recent experiences in the Brush and Edison Companies, the market awaits results with anxiety. There has not been much strength in the shares since the late manager retired, and now they are difficult to sell at anything but what holders call a ridiculous price. Brush Preference, by the way, are continuing their upward career, adding a further 5s. to their price this week, but the Ordinary are unaltered.

Central London Deferred is 2 per cent. to the good at 100½, and the Ordinary has jumped to 104½ upon the investment demand springing up in all directions for Home Railway stocks. Great Northern and City shares are neglected. Districts are strong at 35 on the financial support which the powerful firm of Messrs. Speyer Bros. is extending to Mr. Yerkes's enterprising scheme for putting a girdle round the town by linking the four electric railways with which his name is now connected.

Anglo-American Telegraph issues are dull, except the Deferred, which is ¼ better. The Yankee market is picking up a little business, which should be good for the cable companies, but neither Commercial nor Submarine stock has advanced. Eastern Telegraph Ordinary is weak, although allowance of 1¼ per cent. net must be made for the deducted dividend. The Preference is also a fraction lower.

National Telephone Deferred has been offered to some extent, and a fall of 2 points is the result; otherwise the company's issues are without fluctuation. The Miscellaneous section is featureless.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation April 9th.	Closing Quotations April 16th.	Business done during week ended April 16th 1902 Highest.	Lowest.
82,300	African Direct Telegraph, 4 % Debs	100	...	...	...	99 — 1 3	99 — 103	...	
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½ — 4½	3½ — 4½	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ..	100	...	...	...	70 — 80	70 — 80	...	...
804,720	Anglo-American Telegraph	Stock	73/6	3½%	61s.	45 — 48	44 — 47 xd	...	
3,097,640	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	8 — 91	86 — 88 xd	88	86¼
3,097,640	Do. do. Deferred	Stock	£1 7s.	5s. %	2s.	6½ — 7	6½ — 7½	7	6 1/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	...	3½ — 4	3½ — 4	...	..
13,333,300$	Commercial Cable	£100	8 %	...	..	150 — 160 xd	150 — 160	...	..
1,741,029£	Do. do. Sterling 500 year 4 % Deb. Stock Red	Stock	..	..	...	94 — 96 xd	93 — 96	94	93½
16,000	Cuba Telegraph	10	7 %	.	...	4½ — 5½	4½ — 5½	5	4 15/16
6,000	Do. 10 % Pref.	10			...	13 — 14	13 — 14	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3 — 4	3 — 4	...	..
6,000	Do. do. 10 % Cum Pref.			..	...	8½ — 9	8½ — 9¼	..	..
30,000£	Do. do. 4½ % Debs.	5		..	..	98 — 102 %	98 — 102	...	...
60,710£	Direct United States Cable	10	4 %	3½%	..	9½ — 10½	9½ — 10½	9¾	...
101,300£	Direct West India Cable, 4½ % Reg. Deb., within Nos. 1 to 1,200, Red.	100		..	...	99 — 102	99 — 102	...	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	125 — 135	122 — 132 xd	129	123
1,930,807	Do. 3½ % Pref. Stock	100			...	84 — 87	83 — 86 xd	85½	84¼
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock			...	105 — 109	105 — 109	107¾	106½
300,000	Eastern Extension, Australasia, and China Telegraph ..	10	7 %	7 %		12½ — 13½	12½ — 13½	13	12 5/16
320,000£	Do. 4 % Deb. Stock	Stock	..	...		108 — 113	108 — 113	110	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb Nos. 1 to 3,000, red. 1909	100	5½%	...	...	98 — 101	98 — 101	102½	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	..	100 — 103 %	100 — 103	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	8½ — 9½	8½ — 9½	8⅝	8½
180,042	Do. do. 6 % Pref.	10	...	.	...	12½ — 13½	12½ — 13½	12¼	12⅝
150,000	Great Northern Telegraph, of Copenhagen	10	...	15 %	...	27 — 29	27 — 29	27¾	...
75,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 — 103	99 — 103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	35 — 37	35 — 39	...	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	100 — 104	100 — 104	...	..
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ..	1	2½%	...	...	¼ — ½	¼ — ½	...	..
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	...	.	¾ — 1	⅞ — 1	...	
983,333	National Telephone Pref. Stock	100	5 %	5 %	5 %	95 — 99	95 — 99	97	96
200,000	Do Pref. shares	2	...	3⅛	3⅜	3⅛ — 3⅜	3⅜ — 3⅜	3 5/16	...
1,966,667	Do Def. Stock	100	...	60	64 xd	60 — 64	58 — 62	59	58½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	3 — 15	...	
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	2 — 14	...	
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞ — 5⅛	4⅞ — 5⅛	5	4⅞
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	93 — 96	93 — 96	...	..
500,000£	Do. 4 % Deb. Stock Red.	100	..	4 %	4 %	101 — 105	01 — 105	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	6 %	...	⅞ — 1	⅞ — 1	1	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	..	...	...	99 — 102	99 — 102	...	..
11,839	Reuter's	8	5 %	5 %	...	6½ — 7½	6½ — 7½	...	...
3,303	Submarine Cables Trust	Cert.	..	..	...	115 — 125	119 — 125	...	...
58,000	United River Plate Telephone	5	7 %	...	...	4⅜ — 5¼	4⅜ — 5¼	...	...
40,008	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	..	...	4½ — 5	4½ — 5	...	...
179,947£	Do. do. 5 % Debs.	Stock	..	..	...	102 — 105	102 — 105	..	..
155,600	West African Telegraph, 5 % Debs....	100	..	..	...	99 — 101	99 — 101	...	..
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	..	...	...	⅛ — ⅜	⅛ — ⅜	...	..
150,000£	Do do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	..	...	...	99 — 102	99 — 102	...	..
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	12 — 13	12 — 13	12¼	12
75,000£	Do do. 5 % Debs. 2nd series, 1905 ...	100	..	...	...	102 — 105	102 — 105	...	.
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	99 — 102	99 — 102	...	...
88,321	West India and Panama Telegraph	10	6%	...	...	½ — ¾	½ — ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	.	..	...	5 — 5½	5 — 5½	..	...
4,669	Do. do. do 6 % Cum. 2nd Pref. ...	10	...	...	...	3½ — 4½	3½ — 4½	...	
80,000£	Do do do 5 % Debs., Nos. 1 to 1,800	100	.	...	...	100 103	0 103	...	

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅜ — ⅝	⅜ — ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	100 — 104	100 — 104	...	...
19,761	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	8 %	8¾ — 9¼	9 — 9½	...	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	..	8¾ — 9¼	9 — 9½	9 7/16	...
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9 — 10	9 — 10	9 7/16	9 5/16
50,000	Do. do. do. do 4½% Cum Pref	5	...	...	..	5¼ — ⅝	5¼ — 5⅝	5 1/16	5⅛
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	..	105 —107	105 —107	...	...
34,000	*Chelsea Electricity Supply, Ord	5	6 %	5½%	4 %	5¼ — 5¾	5¼ — 5¾	...	...
150,000£	Do. do. do. % Deb. Stock Red. ..	Stock	..	...	...	110 —113	110 —113	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	4 %	0 %	5 %	8 — 9	8 — 9	...	...
40,000	Do. 6 % Cum Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	...	...
400,000£	Do. 5 % Deb Stock, Scrip. (iss. at £115) all paid		...	...	...	123 —128	1 3 —128	...	...
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	..	...	102 —105	103 —106	105¼	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	4 %	4 %	4 %	8 — 9	8 — 9	8 5/16	8
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12 — 13	12 — 13	12½	1 1/16
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ..	.	.	.	..	107 —110	107 —110	109½	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	7 %	...	6 — 6½	6¼ — 6¾	...	...
20,000	Do. do. 6 % Cum. Pref.			..	...	6 — 6⅛	6 — 6½	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock ..	100			..	106 —109	106 —109	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	11%	12%	10%	10 — 11	10 — 11	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	.	..	101 —104	101 —104	...	..
110,000	London Electric Supply Corporation, Limited, Ord. ..	3	...	...	..	1½ — 2	1½ — 2	...	...
49,840	Do do. do. do 6 % Pref	5	...	...	...	4 — 5	4¼ — 4¾	...	
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	..	95 —100	95 100	96	
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	6½%	14 — 15	14½ — 15½	15 5/16	14½
220,000	Do 4½% First Mortgage Debenture Stock	...	...	...	..	114 —115	111 —115	...	...
250,000£	Do 3½% Mort. Deb. Stock Red.	Stock	...	...	...	99 101	7 100	98	...
8,652	Notting Hill Electric Lighting	10	7 %	7 %	6 %	14 15	14 — 15	14	..
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14½ 15½	14⅞	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	...	...
150,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	1⅞ — 2¼	1⅞ — 2¼	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	..
65,000	South London Electricity Supply, Ord.	5	...	...	.	2¼ — 2⅝	2⅝ 3¼	3½	2⅝
109,518	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11½ — 12½	11⅞	11½

* Subject to Founders Shares.
† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
§ Dividends paid in deferred share warrants, profits being used as capital.
¶ Dividends marked † are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation April 9th.	Closing Quotation April 16th.	Business done week ended April 16th, 1902. Highest	Lowest.
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	88 — 92	88 — 92	...	...
62,074	British Electric Traction	10	8 %	9 %	...	13½ — 14½	13½ — 14½	14	13 15/16
90,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12¼ — 12⅝	12¼ — 12⅝	12⅝	12½
600,000£	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	124 —127	124 —127	125½	125
70,000	British Insulated Wire Ord.	5	20 %	15 %	...	9 — 10	8½ — 9½	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝ — 6¼	5⅝ — 6¼	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	8 %	...	13s. to 15s.	13s. to 15s.	...	...
50,000	¶ „ „ „ 6 % Cum. Pref.	£1	...	6 %	...	16/6 to 17/6	16/0 to 17/0	...	...
105,731	Brush Elecl. Enging., Ord., 1 to 105,731	2	5½ %	5 %	Nil	½ — 1	½ — 1	13/16	...
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	3 %	1½ — 1⅝	1½ — 2	1 1/16	1 7/16
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	101 —104	101 —104	103	102½
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	97 —100	97 —100	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	17 — 18	17½ — 18½	17	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	5⅞	...
90,000£	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	111 —115	111 —115	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	4 %	102 —105	103 —106	105	103½
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	4 %	103 —106	103 —106	105	104
440,100	Do. do. Def. do.	Stock	...	...	4 %	97 —100	99 —102	99	...
855,000	City and South London Railway	Stock	1⅞ %	1½ %	2 %	65 — 68	65 — 68	67½	65
54,000	Crompton & Co., Nos. 1 to 54,000	3	7½ %	8 %	...	3 — 3½	3 — 3½	...	...
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105 %	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	2½ %	...	⅛ — ⅜	⅛ — ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	2½ %	...	2 — 3	2 — 3	...	...
344,023£	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	78 — 83	78 — 83	...	...
100,000£	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	82 — 87	82 — 87	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅝ — 1⅞	1 — 1½	1 1/16	1⅜
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	...	...	...	2½ — 3	2½ — 3	2⅝	...
182,560£	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	97 —101	97 —101	101	99⅜
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9⅜ — 10½	9⅜ — 10½	10 3/16	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	98 —101	98 — 101	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	17 — 18	17 — 18	17	...
35,000	Do. do. do. 4½ % Pref.	5	4½ %	4½ %	...	5½ — 6	5½ — 6	5⅝	...
50,000£	Do. do. do. 4½ Mort. Deb. Stock..	Stock	...	...	...	111 —115	111 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ..	10	10 %	10 %	...	21 — 22	21 — 22	21⅜	21⅛
300,000£	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	99 —102	99 —102	100½	...
37,500	†Liverpool Overhead Railway, Ord.	10	3⅜ %	3½ %	1½ %	5 — 5¼	4⅞ — 5	...	...
10,000	† Do. do. Pref., £10 paid	10	5	...	...	10½ — 11	10½ — 11	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500	10	...	...	...	15½ — 16½	15½ —16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	6 %	...	... — ...	19/0 to 20/0	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	17½ %	20 %	34 — 37	34 — 37	36	34
150,000£	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	... %	...	...	102 —105	102 —105	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	12 %	12 %	...	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94	91 — 94	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 1/16—3/16.
National Electric Free Wiring, 13/16—15/16.
* From Birmingham Share List. ¶ From Manchester Share List.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—15.
Do. do. Pref. (£10 pd.), 10½—10⅝.

Bank rate of discount 3 per cent. (February 6th, 1902).

MARKET QUOTATIONS, Wednesday, April 16th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	89/-	89/-	..
a Ammonia, Muriate (crystal) ..	per ton	£88 10	£88 10	..
a „ „ ..	per ton	£80	£80	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£20	£20	..
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£81	£81	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8d.	8d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£25	£25	..
a Shellac	per cwt.	110/-	114/-	6s. inc.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£8 5	£8 5	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£3	£3	..
a „ Bichromate, casks ..	per lb.	2½d.	2½d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b „ Wire, in ton lots	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £125	..
c Brass (rolled metal 9" to 12") basis	per lb.	6⅝d.	6⅝d.	..
c Tube (brazed)	per lb.	8¼d.	8¼d.	..
c „ „ (solid drawn) ..	per lb.	7d.	7d.	..
c „ Wire, basis	per lb.	7d.	7d.	..
c Copper Tubes (brazed) ..	per lb.	8⅜d.	8⅜d.	..
c „ „ (solid drawn) ..	per lb.	9d.	9d.	..
g Copper Bars (best selected) ..	per ton	£71	£71	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£71	£71	..
g „ Rod	per ton	£71	£71	..
c „ Electrolytic) Bars ..	per ton	£63	£63	..
c „ „ Sheets ..	per ton	£75	£75	..
c „ „ Rod ..	per ton	£68	£68	..
c „ „ H.C. Wire	per lb.	8d.	8d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	8/- to 8/1	3/0½ to 3/1	½d. dec.
t Iron, Charcoal Sheets	per ton	£18	£18	..
t „ Pig (Cleveland warrants) ..	per ton	47/2	47/2	..
t „ Forgings, according to size	per ton	From £11	From £11	..
t „ Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
t „ Wire, galvanised No. 8 ..	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 12 6 to £11 15	£11 10	..
g „ „ Sheet	per ton	£13 10	..	..
m Manganin Wire No. 22	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases), small ..	per lb	8d. to 9d.	8d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	8/8 to 7/8	8/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/3	11½d. to 1/2	..
p „ rolled bars & rods	per lb.	1/- to 1/8	1/- to 1/8	..
p „ „ strip & sheet	per lb.	From 1/2	From 1/2	..
c Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	10d. to 1/-	..
t Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
t „ „ in bars		£58	£68	..
g Tin, block	per ton	£128 to £129	£127 to £128	£1 inc.
g „ foil	per lb.	/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/7	1/7	..
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j „ 6 lea. Flax	per lb.	6½d.	6½d.	..
j „ 3 ply 16 lbs. Russian ..	per lb.	4¼d.	4¼d.	..
j „ 10 lbs. Russian, single ..	per lb.	4½d.	4½d.	..
j „ 180 lbs. Jute rove	per ton	£10 2 6	£10 2 6	..
k Zinc, Sheet (Vieille Montagne brnd.)	per ton	£22 10	£22 10	..

Quotations supplied by
a Messrs G. Boor & Co.
b The British Aluminium Co., Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons.
e Messrs. Frederick Smith & Co.

Quotations supplied by
f India-Rubber, G.-P. and Teleg. Works Co., Ltd.
g Messrs. James & Shakspeare.
h Messrs. Edward Till & Co.
t Messrs. Bolling & Lowe.
j Messrs. Walter H. Hindley & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

* Subject to Founders Shares. † Quotations on Liverpool Stock Exchange.
‖ Unless otherwise stated all shares are fully paid. ¶ Dividends paid in deferred share warrants, profits being used as capital.
§Dividends marked † are for a year consisting of the latter part of one year and the first part of the next.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME NOTES ON POLYPHASE MACHINERY.

By A. C. Eborall.

(*Paper read at Manchester, March 25th*, 1902.)

In the present paper the author presents some notes* bearing on the construction and operation of polyphase machinery of standard types, a discussion of the latest developments in this branch of electrical engineering, such as the compounding of generators and the question of asynchronous generators, and other special machines, being reserved for future treatment. At the same time, an endeavour has been made to make the paper interesting by giving full constructional details of certain modern plant of standard design with which the author is acquainted.

Standard Polyphase Generators.†

The experience gained in the construction and working of large polyphase generators during the last ten years has conclusively shown that for all heavy work the revolving field type of generator is by far the most suitable. Thus this type has been standardised by all the leading firms building large slow-speed generators, and it may be said to meet all the requirements of modern practice. The great advantage of having the high pressure armature windings in the stationary part, where they can be easily and effectively insulated, and which avoids the necessity of collecting high pressure current from slip rings, is the principal reason for this preference, but another great advantage of the type is that the fly-wheel effect necessary for the engine is more easily arranged for in the rim of the revolving magnet wheel (supposing a separate fly-wheel is not used) than is the case with a rotating armature consisting of a spider carrying a heavy laminated core. The mechanical nature of this magnet wheel permits of high peripheral speeds being employed, thus reducing the weight required for a given fly-wheel effect.

Modern practice requires that all the field poles should be wound. Alternately wound poles present several disadvantages from the point of view of magnetic leakage and distribution of the pole flux, while the use of a single central exciting coil (either stationary or rotating) is quite out of the question. This construction was tried in the early days, notably at Lauffen, but was soon abandoned on account of the excessive drop of the machines on inductive loads, due principally to the enormous magnetic leakage of their field systems.

The failure of the Lauffen type of generator led to the development of the inductor generator, which has also proved quite unsuccessful—at any rate, as far as large slow-speed generators for power work are concerned. For *high speed* machines of moderate size, *operating on non-inductive loads*, the inherent defects of inductor generators are not so apparent, and in the past such machines, operating under these conditions, have met with a certain measure of success. But the weight of generators of this type becomes altogether excessive for the case of large slow-speed machines having to work upon inductive loads, and even then they are far less satisfactory than machines of the revolving field class. This is on account of the very harmful effects of magnetic leakage in inductor generators, and also because of the special features of design peculiar to this type of generator, such as half the armature copper remaining inactive, and the large flux densities used in the air-gap and armature core.

As the inherent defects of inductor generators become less apparent at high speeds, such machines can be made a commercial success under favourable conditions with regard to this. Thus, for use with steam turbines, inductor generators could be successfully employed. In this case, owing to the exceptionally high speed of rotation, the number of poles will be small (for standard frequencies), and hence the pitch of the poles can be made large, resulting in small magnetic leakage; for the same reason the number of armature turns will be small, and the pressure drop on inductive loads can be kept within proper limits. Again, from the mechanical point of view, inductor generators offer several advantages in connection with steam turbine work; there are no sliding contacts whatever, and the peripheral speed of the inductor (which can be perfectly balanced) can be made as high as that of the turbine wheel, if desired. In the author's opinion, it is only in conjunction with steam turbines that the inductor generator can be used with good results—perhaps better than those obtainable with other types of generator—and it is somewhat surprising that this type of generator has not yet been tried by steam turbine builders. Naturally, great care must be taken with the design; magnetic leakage must be reduced to a minimum, not only inside the generator itself, but also outside, to the turbine parts, &c. The shafts must be exceptionally stiff, and the bearings specially long, in order to prevent the possibility of trouble from vibration owing to unequal air gaps traversed by the large magnetic fluxes which are a necessity for the type.

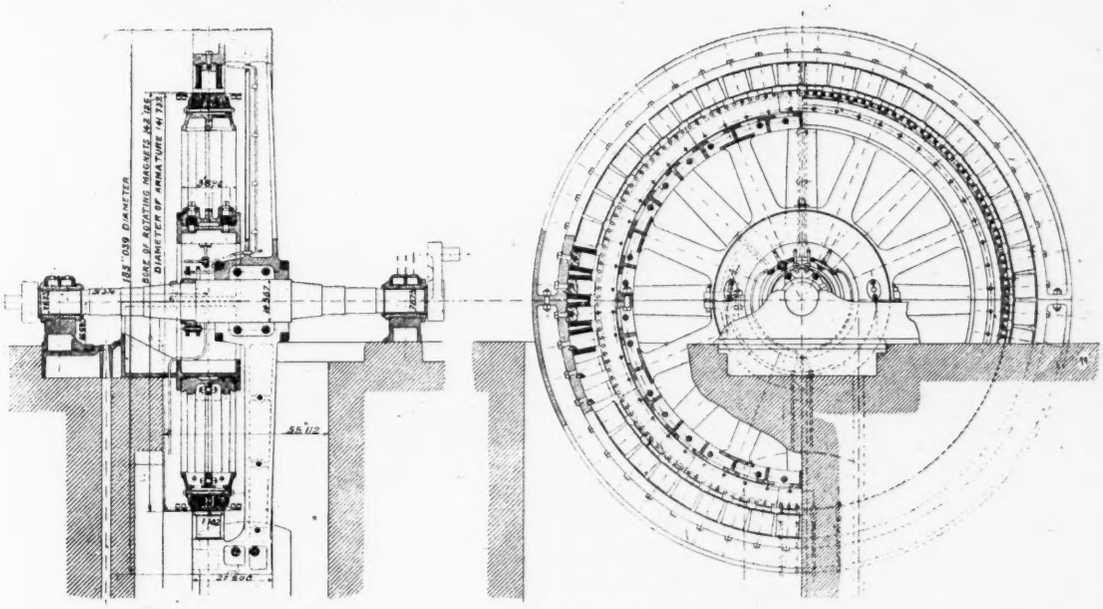


Fig. 1.—General Arrangement of Three-Phase Fly-Wheel Generator with External Revolving Field System. 300—350-kw.; 190 volts; 92½ revs. per minute; 40 cycles; 52 poles. (Brown, Boverie & Co., Ltd., Baden.)

With these preliminary remarks, some points connected with the construction of polyphase generators of the rotating field type will now be considered, large slow-speed fly-wheel type machines being more particularly in mind.

Construction of the Field System.

Both in this country and on the Continent the field systems of modern types of alternating current generators are, as a rule, so arranged, that they also provide the fly-wheel effect necessary for the driving engine. In the States, however, the standard practice* is to provide a separate fly-wheel alongside the magnet wheel, which

* The author has avoided detailed reference to those points connected with the subject which have been comparatively recently discussed by him elsewhere. See Howard Lectures, 1901 (*Society of Arts Reprint*) and *Journal Inst. Elec. Eng.*, Part 150, Volume xxx., 1901.

† Mr. Alexander Rothert has recently collected together the data relative to the construction and performance of the large polyphase generators exhibited at the Paris Exhibition, 1900, which are of considerable interest. The data in question are accompanied by criticisms on the individual machines, and by some valuable notes and conclusions. See *L'Eclairage Electrique* for November 30th and December 7th, 1901.

* Compare the American installations in this country—for instance, Glasgow, Central London Railway, Middlesbrough, &c.

Quotations supplied by
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons.
e Messrs. Frederick Smith & Co.

Quotations supplied by
h Messrs. Edward Till & Co.
i Messrs. Bolling & Lowe.
j Messrs. Walter H. Hindley & Co.

Quotations supplied by
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

may or may not be bolted to the latter. The principal advantages of the fly-wheel generator are that the design is very compact (a point of some importance when the machine is placed between the cranks of a two-crank engine), the shaft and bearings can be made lighter, the ventilation is more than sufficient, while, from the æsthetic point of view, nothing better could be desired. At the same time this type of machine has its disadvantages, especially for very large 25-cycle generators.

With all very large generators (2,000 kw. and upwards) the question of the dimensions of the shaft becomes of great importance, as is easily seen when it is considered that the diameter of the generator shaft of a 5,000-h.p. three-crank engine in the hub will be of the order of 32 in. for a 90-ton wheel. In order to keep down the size of these shafts to manageable dimensions, it becomes necessary to reduce, as much as possible, the weight to be carried—that is, to operate the magnet wheels at very high peripheral speeds, say, 6,000 to 7,000 ft. per minute, and to reduce the length between bearings to a minimum, because for a given diameter of shaft and given weight of magnet wheel, the deflection of the shaft is approximately proportional to the cube of the distance between the centres of the bearings carrying it. Thus, at speeds of the order of 75—85 revolutions per minute, the fly-wheel generators become small in width, and very large in diameter—invariably larger than is necessary in order to obtain the best electrical results. For the lengths of the iron and copper paths become too great, and the these limits of frequency each case must be decided upon its own merits, but it may be remarked that when the prime mover is a gas engine, the use of a separate fly-wheel becomes a necessity, as it is difficult to imagine a single case in which the whole of the necessary fly-wheel effect could be profitably put into the magnet wheel.

When a separate fly-wheel is employed, it is generally preferable to bolt its hub to that of the generator; a connection between the arms is not advisable. But as the short-circuit current of a modern polyphase generator will not be greater than about three times the full load current, and as this short-circuit current will have quite a low power factor, such a point as this has not the importance it has in direct-current work, where the effects of a short circuit are far more serious.

With regard to the construction of the magnet wheels of fly-wheel generators of large size, which, as already seen, operate at very high peripheral speeds, it is clear that these must be of steel throughout. Experience shows that the working peripheral speed of a double-armed cast-iron wheel is limited to about 5,000 ft. per minute, while that of a similar cast-steel wheel will be about 7,000 ft. per minute; if, however, the magnet wheel is of the built-up type, the poles and yokes being of steel (either solid or laminated), dovetailed into a cast-steel rim carried and supported by rolled steel plates instead of arms, this value may be exceeded. With such a construction—which is, however, a most expensive

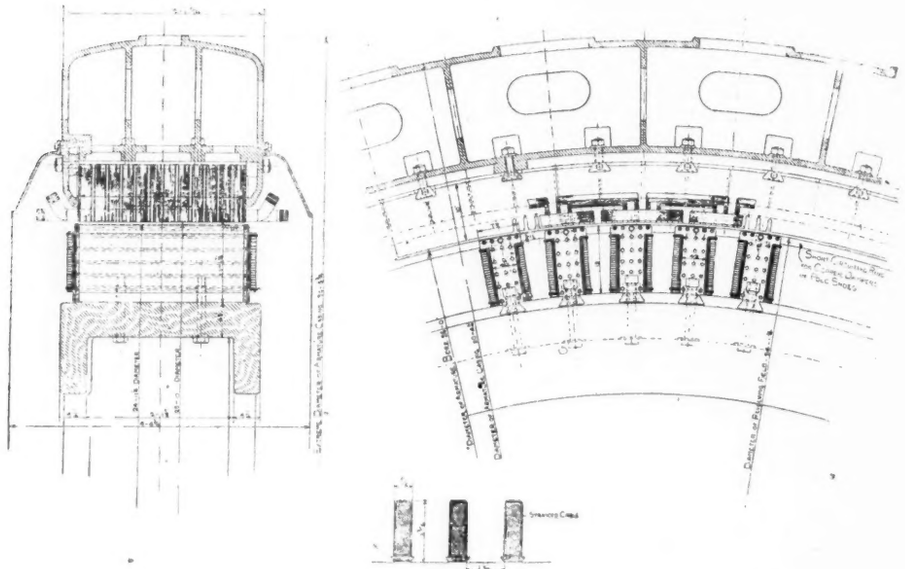


Fig. 2.—Sketch of a Three-phase Fly-wheel Generator, showing Dampers. 4,000 kw.; 6,600 Volts at the Terminals; 75 Revs. per Minute; 50 Cycles; 80 Poles.

weights of these materials consequently increase, if a given efficiency is required; this is most noticeable in 25-cycle generators, where the magnet wheel carries comparatively few field poles. But of greater importance are other considerations that are a direct consequence of the generator being designed from the fly-wheel, rather than from the electrical point of view; on the one hand, it is not such an easy matter to design the stationary armature with the necessary stiffness, and this stiffness can in any case only be attained at a certain cost, as the weight of idle material in the armature may become considerable, or special stiffening arrangements may be required. On the other hand, the cost of the machine increases considerably with the diameter, on account of the increased expenses in tooling and erecting it, and in transporting it, to say nothing of the fact that such machines cannot belong to a standard series, on account of the varying requirements with regard to fly-wheel effect, and hence new drawings and patterns are required for nearly every case.

The question of the design of the armature casing, in order to get the necessary rigidity, will be referred to in the next section of this paper, but from what has been said it will be seen that it by no means follows that the fly-wheel type of generator (which must often be a compromise between conflicting electrical and mechanical considerations) is the best possible type for all classes of work, requiring widely different frequencies. As a rule, for large 25-cycle generators, the best arrangement from all points of view is that in which a separate fly-wheel is employed, so that the generator can be designed for the best results, quite apart from the requirements of the prime mover. On the other hand, for 50-cycle generators, owing to the much larger space required for the poles, and also owing to considerations of magnetic leakage, the natural diameter of the magnet wheel will approximate to that of the fly-wheel necessary, so that the two functions can be combined, and a fly-wheel generator can be employed with very good results. Between one—a peripheral speed of 8,000 ft. per minute can be safely employed.

The above remarks are applicable to the standard arrangement of polyphase generators, in which the stationary armature is external to the magnet wheel; under these circumstances the latter is subjected both to mechanical and magnetic stresses, the former being by far the more important. The drawing (fig. 1) shows, however, a design in which the magnetic pull works against the centrifugal forces; it is a characteristic construction due to Mr. Charles Brown, which has been used by him with considerable success in several installations, notably at Cairo. In addition to diminishing the mechanical stresses on the magnet wheel, this construction possesses other advantages; for a given fly-wheel effect the weight of metal in the rim of the magnet wheel is reduced to a minimum, as this weight is concentrated on the greatest diameter of the generator, thus reducing the diameter of the generator as a whole, so that the quality of the electrical design need not be sacrificed to the mechanical requirements. The stationary internal armature can be designed simply from the point of view of what is best from the electrical and magnetic points of view, and, consequently, the objection to the fly-wheel type of generator already noticed above nearly or entirely disappears. The principal data of the generator shown in fig. 1 can be obtained from the drawing and from the schedule below:—

Schedule I.

Output ($\cos\phi = 1$) external revolving field three-phase fly-wheel generator of	350 kw.
Terminal pressure	190 volts.
Current per phase	1,060 amperes.
Revolutions per minute	92·5
Frequency	40 cycles.
Number of magnet poles	52

Peripheral speed of magnet wheel in feet per minute at the polar bore	3,440
Ditto ditto at the external periphery	4,550
Diameter of polar bore...	142·12 in.
„ armature	141·73 „
Air-gap length (iron to iron)	0·197 „
Gross width of armature core...	10·8 „
Net ditto (10 per cent. paper)	9·0 „
Depth of armature core	6·7 „
Total number of armature holes	156
Diameter of these (circular) holes	1·8 in.
Number of bars per hole	1
Nature of armature connection	Star.
Diameter of the pole cores	5·15 in.
Dimensions of the (solid) pole shoes...	(11 × 5·15) „
Number of turns per pole core	80
Nature of field winding	Copper strip on edge in two parallel circuits.
Resistance (cold) of field winding	0·95 ohm.
Field current at no load	65 amperes.
„ full load (cos ϕ = 1) ...	77 „
„ ditto (cos ϕ = 0·85) ...	100 „
„ on short circuit with 1,200 amperes	35 „

The disadvantages of this type of generator are not serious; they are, first, it is not altogether an easy matter to get at the armature coils for cleaning and repairs; and, secondly, such a machine demands a good deal of experience of a special kind on the part of those designing and constructing it. With regard to the first point, the arrangement devised by Messrs. Brown, Boveri & Co. consists in so arranging the armature that, after removing a few bolts, it can be barred round the central hub on which it is carried, which hub forms part of the heavy sole-plate carrying the outer bearing and (perhaps) the exciter. In addition, half the armature can be moved parallel to the shaft towards the outer bearing, along a suitable slide. Thus if it is required to get at the lower half of the armature, the bolts securing the armature spider to the central hub are removed, and then the whole armature is barred round until the lower half is on top, the division line being horizontal. The bolts uniting the two halves are then removed, and the upper half drawn along the slide towards the outer bearing by means of a screw gear provided for the purpose, until it is quite clear of the magnet wheel. If the generator is between the engine cranks (as in fig. 1), the bearing nearest the armature takes the place of the outer bearing in this description.

Returning now to usual constructions, consisting of a double-armed steel wheel carrying a crown of poles on its rim, the question of the field poles themselves may next be touched upon. Opinions differ as to whether these should be laminated throughout, or solid throughout, or consist of solid cores and laminated shoes. Naturally this question is very intimately connected with the design of the armature, because this determines the pole heating caused by variation in, and unequal distribution of, the flux entering the armature core from the pole-shoes, and *vice versâ*. If the windings of the armature are placed in holes, there being three or more holes per pole per phase, and if the air-gap is not too small, there is no doubt but that solid cast steel poles can be used with the very best results, and such poles (solid cores and solid shoes) can also be used under similar circumstances when the holes are just opened by means of a very narrow slit. A solid pole throughout presents the advantage for large slow-speed generators that the parallel running of these is undoubtedly assisted. The solid pole-shoes act to a certain extent as dampers, that is to say, when the magnet wheels of the generators running in parallel have a tendency to swing relatively to one another, which swinging will be accompanied by a synchronising current of greater or less amount, and which may develop into hunting, the swinging will be retarded and limited in amount. The momentary alterations in the angular velocity, due to irregularities in the turning moment of the engines (however brought about) cause the distribution of the air-gap flux to vary, with the result that currents are induced in the solid pole-shoes. The effect of these currents tends on the one hand to keep the angular velocity constant, and on the other hand, causes the velocity changes to take place more gradually and to be of the same character simultaneously in the various generators in parallel, in this way limiting the swing.

But this effect, useful though it may be, should not be allowed to stand in the way of the best electrical design for the generator in question, for the same result can be attained in other ways. As will be seen later, the armature coils of large generators will be former-wound in open or nearly open slots, and this construction most certainly calls for laminated pole-shoes. The point, therefore, arises, will it be better to laminate the poles throughout, or shall the pole cores be solid and the shoes alone laminated? Such a point as this must of necessity be largely determined from manufacturing considerations. If the pole-shoes alone are to be laminated, such considerations prescribe that they shall be cast into the pole cores. On the other hand, if the manufacturer in question does not possess his own steel foundry, he will hesitate to get such complete poles made outside, and will, as a rule, laminate the poles throughout.

There is not a very great deal to choose between the two constructions from the purely technical point of view. The steel pole-core will have a slightly higher permeability than the sheet-iron core, and will make a better job from the points of view of attaching it to the rim of the magnet wheel, and of supporting the field coils, as these will not overhang the sides of the wheel, and can be secured by means of the pole-shoes, which will be made wider than the cores. It possesses the further advantage—which in certain cases is a considerable one—that it can be round or oval, thus saving copper and diminishing the magnetic leakage between adjacent poles. The sheet-iron core is of necessity rectangular in section, and hence not so good in these respects. Again, the windings for rectangular pole-cores are not so easily carried out as those for round or oval cores, while, as the width of the core is equal to the width of the shoe, the windings have to be secured by means of special metal cheeks, as already indicated. On the other hand, such complete poles are, in general, shorter, because the depth of the pole-shoe will be less, the casting-in of the latter requiring a certain amount of extra length; consequently the magnetic leakage between the pole-shoes themselves will be greater when these are cast in.

(To be continued.)

TESTS ON THE NERNST LAMP.

By R. P. Hulse, Bowen Scholar, Birmingham University.

(*Paper read at Birmingham, March 19th, 1902. Communicated by Dr. D. K. Morris.*)

It has been known for a long time that certain materials which insulate at ordinary temperatures will conduct fairly well when strongly heated, and this principle has been employed in connection with the electric furnace, but it was not until lately made use of successfully for the purposes of illumination. About four years ago Dr Nernst applied this principle in the construction of his lamps and used material for their manufacture very similar to that used in Welsbach mantles. Owing to the fact that the melting point is very high, a much higher temperature can be maintained than with a carbon filament, and a higher efficiency lamp is the result; and, the material being also non-oxidisable, no vacuum is necessary. The materials used for the illuminating rod require to be heated up in order to start the current flowing; but when once heated the rod conducts and need no longer be heated by external means.

A great deal of experimenting and improvement has been necessary to bring the Nernst lamp to its present state of perfection, but the "1902 Model" now being put on the market appears to be a fairly satisfactory article; and it is this lamp which forms the subject of the tests described in this paper.

These tests comprise the measurement on a direct-current circuit of life, candle-power and watts under the following conditions:—

Continuous run at normal pressure.
Continuous run at a pressure above normal.
Continuous run at a pressure below normal.
Continuous run with constant current.
Continuous run with constant watts expended in rod.
Tests with varying volts (increasing till burner is destroyed).
Resistance tests on the iron regulating resistance.
Heating effect of coil.

In each case 100-watt 110-volt "burners" were employed.

The candle-power of the lamps was ascertained by comparison with standard Ediswan glow lamps standardised by the makers, using an ordinary grease-spot photometer. This photometer was not inverted, but the sub-standard which was employed for taking the actual measurements was itself standardised by comparison with the actual standard lamp placed on the same side of the photometer as the Nernst lamp had been.

All parts of the photometer bench and apparatus directly exposed to the light that could possibly have affected results by reflection, were painted a dead black, the resulting surface being almost absolutely non-reflecting. To enable more than one lamp to be tested at the same time, and also to avoid shaking the lamps when moving them, four wooden vanes were fixed to a hollow central stem which was pivotted vertically so that four lamps could be hung in the four compartments and any one lamp tested by simply turning this frame round till that lamp was in front. All light from the other lamps was excluded by screens placed round this compartment and at the sides. To allow for ventilation and cooling of lamp by air currents the globes were hung a short distance from the side, the top and bottom of the frame being left open. All the lamps tested were protected by globes, and the results obtained from a ground-glass globe reduced to the clear-globe standard for comparison. The candle power was taken in the horizontal plane with the filament always vertical.*

The current supplied to each lamp was measured by a millivoltmeter and strips of known resistance, and the pressure was measured by a Weston moving-coil voltmeter previously calibrated in terms of a standard Clark cell. The drop across the iron resistance and across the cut-out coil was obtained from another small moving-coil instrument. The necessary corrections were made to the readings given by these instruments to obtain the true values. The pressure on each lamp was adjusted by small carbon cloth rheostats or by stretched wires with sliding contacts, and was always brought up, when necessary, to the required value before a reading was taken.

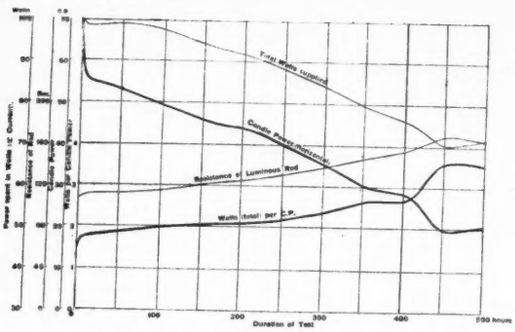
As a battery of accumulators was used to supply the current, a very much more steady pressure was maintained than would have been possible with the mains, the excess volts when charging the battery being cut down by a regulating resistance. The average variation in pressure for any long time was certainly not more than ½-volt, and generally less; and it will be seen later that, since under perfectly steady conditions the lamp itself varies 2 to 3 per cent., sometimes more, a steadier run was hardly required.

* For information on the distribution of light in Nernst lamps, and on the ratio of horizontal to mean spherical C.P., see Prof. Wedding, *Elektrotechnische Zeitschrift*, August 1st, 1901. Other information is given in a paper by A. J. Wurtz, *Jour. Am. Inst. E.E.* 1901.

The life was in all cases, unless otherwise stated, perfectly continuous, only one break occurring in the circuit during the seven weeks, and that for but a few seconds.

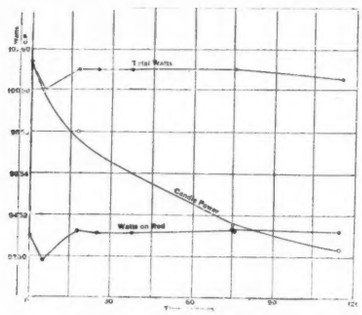
Life Tests.

In every life test made there was a very considerable falling off in candle-power in the first half-hour amounting to 25 per cent. in the over-run lamp,* but only about 10 per cent. when on normal volts. After this we get a much slower drop until 20 hours is reached, then, as a rule, there was a slight recovery followed by a period in which the variations depended on the conditions under which the lamp was run.



Curve 1.—Life Tests at Normal Voltage.
Average of three tests on 100-watt, 110-volt lamps.

1. *Tests at Normal Voltage.*—Three lamps, each marked 100-watt, 110-volts, were tested on 109·5 volts and a mean curve plotted from the three sets of curves obtained. These three were substantially the same, the big decrease (curve Ia) and slight recovery being shown in each; and after this, a steady diminution of candle-power



Curve Ia.—Life Test on One Lamp.
(First two hours after lighting.)

until 400 hours, the efficiency during this part also diminishing (see curve I.). After 400 hours there was another sudden drop, and then the state of the rod seemed to change, for there was a slight rise in efficiency and candle-power up to the point where the burner broke down.

TABLE I.—Life Tests on Normal Volts (109·5).
Mean values from curves representing three separate tests.

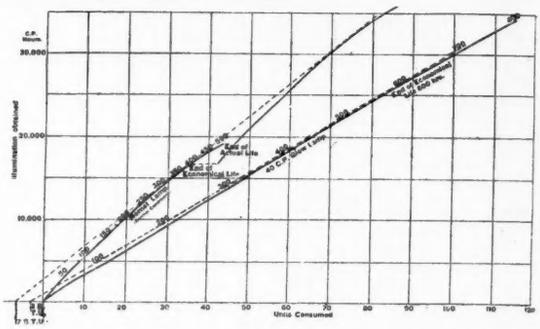
Hours after start.	Current.	Watts absorbed.		Candle power.	Watts per c.p.		Resistance of rod.
		Total in lamps	Per cent. on rod only.		Total.	Rod only.	
	Amps.						Ohms.
0	·917	100 5	88·4	66 8	1·51	1·33	105·6
1	·913	100	89 1	62·9	1·59	1·42	106·8
3	·906	99·2	90·1	57 6	1·72	1·55	108·9
10	·903	98·8	91·2	55 4	1 79	1·63	110·7
50	·904	99·1	92·7	52·9	1 87	1·74	112·2
100	·894	97·7	94·0	49·4	1·98	1 86	115·2
150	·858	94 0	95·1	45·7	2·06	1·96	121·2
200	·836	91·6	95 7	43 9	2 09	2·0 0	125·2
250	·803	88·0	96·1	40 0	2·20	2·11	131 0
300	·766	83·9	96·7	35·4	2·37	2·29	138·2
350	·724	79·3	97 3	30·1	2·64	2·57	147·0
400	·692	75 8	97 7	28·5	2 66	2·60	154·5
450	·637	69·8	98·2	19·4	3·61	3·54	168·8
500	653	71 5	98·0	20·4	3 51	3·44	164·2

The respective lives of the three lamps were 509, 490, and 425 hours, the average being 473 hours. The cause of destruction in each case was the breakage of the platinum contact at the positive end of the rod. This may have been due to the deterioration of contact and consequent local heating.

Length of Efficient Life ("*smashing point.*")—It will be seen that towards the end of the life the efficiency is seriously decreased, the lamp being ultimately no more efficient than an ordinary glow-lamp.

In 1885 Ayrton* showed graphically how to find the most economical voltage at which to run a lamp; and later† he described how, at a given voltage, with lamps whose economy decreases with age, there is a point at which it will pay best to discard the lamp. This point is known as the "smashing" point. In 1898 Carter‡ gave a construction by which this point could be deduced. A more direct way based on this method is the following:—

Express by a curve the relation for the lamp (at the pressure under consideration) which exists between the cost of energy expended and candle-power-hours obtained, the latter being plotted vertically. From the common zero, set backwards horizontally the cost of the refill for the lamp.§ A tangent from the point so obtained to the curve gives the point at which the c.p.-hours will bear the greatest ratio to the total expenditure; and it is at this point that it will best pay to get a new burner.



Curve 2.—Construction for finding Duration of most Economical Life.
Assumptions as to cost of renewals:—Nernst lamp, 7 units = 1 new burner; Glow lamp, 3 units = 1 new lamp.

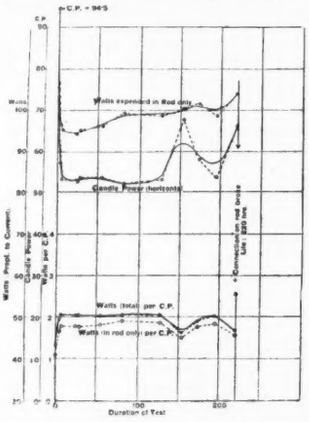
Such a curve (No. II.) has been obtained from Table I., and from it the following figures have been taken:—

Length of run (hours) ...	100	200	300	400	500
Units consumed	9·88	19·31	28·12	36·09	43·28
c.p.-hours obtained ...	5,280	9,890	13,880	16,970	19,170

Assuming the cost per unit to be 6d., and that of the burner, fitting, and depreciation of lamp and resistance as 3s., it is found by this method that it will pay to get a new burner at 350 hours; total cost being up to that point 19s.; candle-power-hours=15,500 or ·0147d. per c.p.-hour.

Under the very best conditions, with power at 6d. per unit, a glow lamp will cost over ·02d. per c.p.-hour.

The relatively short life of the Nernst lamp (about 450 hours) is probably not disadvantageous, since it prevents the use of the lamp under uneconomical conditions after the proper "smashing" point has been reached. The natural life of the burner is very near that at which it will best pay to replace it as calculated above. This is very far from being the case with most glow lamps.



Curve 3.—Life Test (over-run) at 116 5 volts.

2. *Over-run Test.*—This shows that over-running is not only detrimental to the life of the lamp, but also that there is not the gain in efficiency which occurs with an ordinary glow lamp.

That Nernst lamps cannot be over-run is obvious from the fact

* This initial reduction is characteristic of the Welsbach burner also and, as pointed out by Fleming in the discussion of Swinburne's paper in February, 1899 (see *Electrician* February 10th, 24th, 1899), is a property of all oxides used as illuminants.

* See *Electrician*, March 7th, 1885.
† *Electrician*, September 29th, 1893.
‡ Electrical Review, August 19th, 1898.
§ To this should be added any increase in rate of depreciation of the iron resistance due to using a new burner; and subtracted any allowance which may be obtainable for the platinum heating coil in the discarded one.

that the iron resistance protects the burner from excessive pressure, and also owing to the failure of joints on the rod itself if kept at too high a temperature; quite a number of small particles of the paste used to cement the joint at the positive end being found at the bottom of the globe at the end of the test.

Table II. (See Curves III.)

Life Test on Constant Pressure (Over-run, 116·5 Volts).

Hours after start.	Total watts supplied.	Candle-power.	Watts per candle-power.	
			Total.	Rod only.
0	125	94·5	1·32	1·10
½	123	71·5	1·72	1·42
2	117	62·0	1·9	1·54
5	110	52·3	2·10	1·82
15	108·5	52·3	2·08	1·81
50	108·5	53 9	2·02	1·79
100	110·9	52.6	2·11	1·88
150	110·2	61·0	1·84	1·65
200	108·7	58·8	1 85	1·70

The percentage of energy absorbed in the iron resistance is greater than it is with lamps tested on normal volts, but the watts expended on the rod per candle are a very little less. The behaviour of the rod was somewhat uncertain, and it appeared that the lamp was on the point of going a short time before it actually broke down. The life was very short—only 220 hours—and failure was again due to breakage of joint at positive end.

The rod had the same appearance at the end of its life as one run for much longer on normal volts, but there was a heavier black deposit on the porcelain base.

(To be continued.)

OUR LEGAL QUERY COLUMN.

Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"Power Contractor" writes:—"Can you inform us whether a corporation supplying electricity can refuse to give current within their area? We have a small job on hand, but cannot proceed, as the resident engineer refuses to supply our client without a guarantee of £2 per annum. There is no mention of a guarantee in their rules and regulations. We would be greatly obliged if you would inform us whether we can enforce a supply to our client."

*** We presume that the corporation in question are acting—as all corporations supplying electric light must act—under some provisional order or special Act. The following opinion is, therefore, given on the supposition that the usual form of provisional order affects the question of supply by the corporation mentioned by our correspondent. That form contains a provision to the effect that any consumer within the given area is entitled to a supply subject to this, that, "if required by the undertakers, he must enter into a written contract with them to continue to receive and pay for a supply of energy for a period of at least two years of such an amount that the payment to be made for the supply at the rate of charge for the time being charged by the undertakers for a supply of energy to ordinary consumers within the area of supply, shall not be less than £20 per centum per annum on the outlay incurred by the undertakers in providing any electric lines required under this section to be provided by them for the purpose of the supply, *and, if required by the undertakers, give to them security for the payment to them of all moneys which may become due to them by the owner or occupier in respect of any electric lines to be furnished by the undertakers and in respect of energy to be supplied by them.*" We are not informed as to whether the corporation have been put to any expense in laying down mains, &c., for the purpose of giving the supply in question. It is, therefore, doubtful whether our correspondent's case is affected by the first part of the above clause. With regard to the words in italics, however, it seems that these will entitle the corporation to demand the £2 in question.

We cannot give a more definite opinion without further information.

"Suburban" writes:—"I wired a factory for 350 lights. The current was supplied by the Council on the three-wire system, at a pressure of 230 volts, for lighting from the middle wire to either of the outers, and 460 volts for power on the two outers alone. The wiring has been done practically under the supervision of the Council's engineer, and the installation tested and the light put on, the tests being satisfactory.

"I signed an agreement when I started the job, to do it to the satisfaction of the Vestry's engineer, but now the consulting engineer steps in and orders the consumer to have the system altered by putting two lamps in series, and work them across the outers, 460 volts.

"1. Do the Board of Trade allow this? and

"2. How can I apply to them for their regulations?

"The consumer says I must do the alteration according to my agreement. Also the consumers have an agreement with the Council to take a certain amount of current per annum, and the Council to supply same, providing the interior wiring is done according to their rules, &c. I have worked under the engineer, and according to the rules.

"3. Can the consumer take legal proceedings should the Council cut the current off, as they threaten to do, unless the alterations are done?

"4. Can you inform me whether a continuous current can be transformed from 460 volts to 230 volts with advantage?"

*** With regard to the above questions, (1), (2) and (4) can hardly be described as legal queries. We would suggest, however, that, upon application to Messrs. Eyre & Spottiswoode, our correspondent will probably obtain the regulations to which he wishes to refer.

With regard to the third question, it seems that the consumer must be held bound by the contract into which he has entered with our correspondent. That contract seems to be that "he will do a certain job to the satisfaction of the Vestry's engineer," and upon the facts before us, it appears that this term has been complied with. Unless there is some clause in the agreement providing that our correspondent is to be held responsible for subsequent alterations rendered necessary by changes in the Council's rules, we do not see how he can be held liable.

MR. FULTON ON PATENT LAW.

An account of an interview with Mr. Fulton, author of the standard work on "The Law and Practice relating to Patents, Trade Marks and Designs," on the Patent Law Amendment Bill, is published in the *Financial Times* of April 7th. As Mr. Fulton's arguments represent very completely the usual point of view of the opponents of the official examination of inventions for novelty, a discussion of these arguments cannot fail, we think, to be of value in forming an estimate of the changes proposed in Mr. Balfour's Bill.

Mr. Fulton is now an out-and-out opponent of any practicable kind of preliminary examination of patents for novelty, though when he was young and inexperienced in 1877 he was a vigorous advocate of this policy. There is, however, an ideal kind of examination which Mr. Fulton believes in, namely, an examination which would give a guarantee of validity; but, as that is admittedly impracticable, Mr. Fulton's opposition is never likely to be relaxed.

The principal objection of Mr. Fulton to examination for novelty is, that "under the most favourable conditions there is not, and there cannot be, any guarantee of novelty." In support of this view, he alleges that statistics show that in all countries where examination exists, quite as large a proportion of patents turn out afterwards to be bad as in this country. The statistics given by Mr. Benjamin Thwaite before the Society of Engineers, show that in America only 26 per cent. of tested cases prove to be invalid, while in this country the percentage is 42. This does not support Mr. Fulton's view, and he quotes statistics from the Transactions of the Institute of Patent Agents which apparently do. Evidently there is no agreement as to what statistics show on this point.

Assuming for the sake of argument that the statistics quoted by Mr. Fulton are correct, and that it is a fact that, in countries where there is a preliminary examination, the same percentage of patents are afterwards upset in the Courts as in this country, does that show that preliminary examination is of no value? In our opinion it does not, because the patents that come before the Courts in this country are not a fair sample of the unexamined patents which are granted. Patents which come before the Courts are, as a rule, patents that have been subjected, at the cost of the parties interested, to as strict an examination as any official examination is likely to be, and it is not therefore to be expected that there will be much difference in the percentage of patents upset by the Courts in Germany and the United States, where preliminary examination is in force, and in this country where there is no such examination.

What, then, it may be asked, is the use of preliminary examination of patents for novelty? The answer is that even though the patentee has no greater security for the validity of his patent (a very doubtful assumption), the public are protected from being blackmailed by the bogus patentee. Sir Edward Fry's Committee have shown that at least 42 per cent. of the patents granted in this country appear to have been anticipated in whole or in part. A royalty paid on any one of this 42 per cent. by a manufacturer or by a consumer of the patented article is blackmail collected with a legal sanction. The fallacy of Mr. Fulton's point of view is evident. He considers that the Patent Law is solely for the protection of the patentee—the bogus patentee as well as the *bonâ fide* patentee; the public are to receive no protection except they are willing to incur the cost of expensive litigation. That this implicitly, if not explicitly, is his point of view is evident from the following remarks made by him to the *Financial Times* interviewer:—"We come to more serious defects still in the way in which it is intended to carry the policy out. The Bill provides that when the Comptroller has made the investigation, in respect of a new application, and has found perhaps that there are certain prior patents that in his opinion affect, if they do not altogether supersede, the alleged new invention, he is to point this out to the applicant and tell him that he must amend his own specification accordingly. And if the applicant refuses, believing no such similarity or anticipation exists? Well, it is the Comptroller's duty to say to him: 'Very good; I

will grant you your patent, but to punish you for your obstinacy I will endorse upon your specification an official notification that it has been anticipated partly or wholly by these prior patents.' The applicant may appeal to the Law Officer, but he may find himself scarcely any better off What, then, is the market value of the man's invention? Will he get any company or firm to take it up branded with such a bar sinister? Of course not; practically it will lose all commercial value, however excellent it may be intrinsically, and however cleverly the inventor may explain the blot away."

Unless Mr Fulton believes that all patents applied for under our *laissez faire* system are necessarily novel, the Comptroller's endorsement must occasionally be correct. But Mr. Fulton makes no exception for such cases; he still bewails the loss of commercial value, even of the bogus patent.

Though we have not been able thus far to agree with Mr. Fulton, we strongly support two suggestions of his for the amendment of the present Patent Law, namely: the granting of power to a patentee to renounce his patent when he has discovered that it is not novel, instead of making him pay the heavy costs of revocation before the Courts as at present; and, secondly, the amendment of opposition proceedings in the case of fraud, by giving power to the Comptroller to transfer the patent from the thief to the true inventor. It is to be hoped that provisions to remove these serious grievances may be introduced into the Bill.

CURRENT SPECIFICATIONS.

XCVIII.—BEXLEY LIGHTING AND TRAMWAYS.

SUMMARY.

Extent of Contract.—Specification No. 2.—Supply, delivery, and erection, upon prepared foundations, of two 150 KW. steam engines, alternators, and direct current dynamos.

Arrangement.—Each engine is of 150-KW. output, and has coupled to it a 150-KW dynamo; outside this an alternator of same output is placed.

System of Working.—The lighting system is arranged for single-phase alternating current distribution at 2,000 volts, the tramways using direct current at 550 volts. Either set can be used to supply either system up to a total of 150 KW., the output of the engine.

Speed of Set.—To be 375 revolutions per minute.

Steam Pressure.—140 lbs. per sq. in.

Superheat.—Superheated steam will be supplied to engines, and tenderers are to state what is the limit of superheat, expressed in degrees Fahrenheit, within which they can guarantee satisfactory working.

Range of Governing.—On suddenly changing from full to half load momentary variation of speed not to exceed 3 per cent., or from full to no load, 5 per cent. Speed to be variable by hand whilst running, within 5 per cent.

Speed Variation.—The maximum variation in speed during any revolution must not exceed one-half of 1 per cent. of the mean speed, and suitable means must be taken to secure this.

Permissible Overload of Engine.—To be stated in tender.

Steam Consumption.—The steam consumption per B.H.P.-hour at full and half loads to be guaranteed, and bonus and penalty adjustments of contract price will be made upon the actual half-load figures secured as stated below.

Type of Alternator.—To be either of inductor type or multipolar type, wound for single-phase working.

Frequency.—50 cycles per second.

Exciters.—To be direct coupled, mounted on ends of shaft.

Voltage.—2,000—2,100 volts.

Permissible Temperature Rise.—With 72 amperes flowing, not to exceed 60° F. above surrounding atmosphere, measured electrically.

Efficiency of Alternators.—Not to be less than 92 per cent.

Regulation.—When excited to 2,100 volts on full non-inductive load, pressure not to rise above 2,200 volts on removing the whole load.

Dynamos.—To be shunt-wound, arranged to give 550 volts at full load.

Permissible Temperature Rise.—As for alternators.

Efficiency of Dynamos.—Not to be less than 93 per cent.

Specified Delivery Dates.—To be given in tender.

Penalty for Late Delivery.—One-half of 1 per cent. per week of the value of each complete machine late.

Period of Maintenance.—Twelve months from date of completion.

Terms of Payment.—80 per cent. on completion of satisfactory test on site, 10 per cent. three months later, 10 per cent. nine months after payment of above 10 per cent., or twelve months from date of test.

Sureties.—Two to be provided, to be bound jointly and severally to extent of 20 per cent. of contract price.

Stipulations as to Removal of Foremen.—None.

Stipulations as to Wages to be Paid to Workmen.—None.

Arbitration Proposals.—Satisfactory.

Date for Receipt of Tenders.—April 28th, 1902.

This specification has been prepared and issued by Messrs. Mordey & Dawbarn, the consulting engineers to the Bexley Urban District Council.

Two sets of plant are asked for, tenderers being requested to give the price at which they would be willing to supply a third set, if ordered within three months of the acceptance of the tender for the main sets. It is open for tenderers to make offers for the engines only, or for the dynamos and alternators only, but not to tender for dynamos and alternators separately.

The combination of an alternator and dynamo with the engine the output of either alternator or dynamo being equal to that of the engine, is unusual in this country. We believe that Plymouth is almost the only town in which the same course has been adopted. The object is doubtless to permit of the engine power being utilised to the best advantage in supplying either the lighting or tramway system, but whether such a combination has advantages in practice which compensate for its apparent high capital outlay is open to question. It will be noticed that the dynamos are specified to be shunt-wound and to generate at 550 volts at full load.

The special feature of the specification is the series of bonus and penalty arrangements dependent upon the results of the official tests. The steam consumption per *B.H.P.-hour* at *half-load*, the temperature rise of the alternator, the alternator losses on open circuit, the range of regulation of the alternator, the temperature rise of the dynamo and the efficiency of the dynamo, are each made the starting points from which bonuses are reckoned if certain specified improvements on the guaranteed figures are obtained, and penalties are enforced if the guaranteed figures are not reached within certain limits. Messrs. Mordey & Dawbarn carry this principle farther than is the usual practice of other consulting firms, but as the conditions are clearly stated in the specification, it is fair to both tenderer and purchaser, and it renders it possible for a considerably enhanced price to be obtained for a specially good machine. The valuations placed by the engineers on the various points are interesting. They are £50 for each complete pound of steam per B.H.P.-hour at half load, £5 for every 1° F. difference in temperature rise in either alternator or dynamo, £4 for every 100 watts difference from certain amounts in open circuit losses for the alternator, £2 for every 10 volts difference in the rise in volts on open circuit in the alternator, and £50 for every 1 per cent. difference in efficiency in the dynamo from 93 per cent. at full load. The general conditions are fair to all parties, and may be accepted without demur. The arbitration clause is unlimited; there are no stipulations as to labour conditions, and the terms of payment are in accordance with usual practice.

Tenderers should note that when sending in their tender, *every page* of the general conditions and specification must be initialled, and it is also interesting to know that additional copies of the specification may be obtained, at the discretion of the engineers, for a payment of 5s. per set.

THE MISUSE OF COAL.

By W. HIBBERT.

In a short review of a work on "Primary Batteries," included in this number, attention is drawn to a section on carbon-consuming cells, and all young engineers are urged to inform themselves of the possible thermo-dynamic superiority of a primary battery over a steam engine. Prof. Perry has just written a long letter to *Nature*, in which he pleads for a national awakening with regard to our misuse of coal, and boldly suggests that a million sterling be put aside for two or three years in order that leading scientific men like Lord Kelvin or Lord Rayleigh may command the services of all scientific workers likely to be of use in finding the new way of using our fuels.

Primarily, Prof. Perry has in mind the very low thermo-dynamic efficiency of even a good steam engine. Perhaps the readiest way of exposing this is to write down what 1 lb. of Welsh coal will do in producing energy, first, as heat, secondly, as the mechanical equivalent after passing through boiler and engine. The ratio is roughly 12 to 1. Thus:—

1 lb. of coal gives 15,500 thermal units = 12,000,000 foot-pounds of work, using Joules's equivalent, 777.

1 lb. of coal gives $\frac{1}{2}$ H.P.-hour = 1,000,000 foot-pounds of work nearly.

These are not Prof. Perry's figures, but they are well known. As he says, the best and largest steam engines utilises less than 10 per cent. of the energy of the coal; small engines only 1 per cent. A central station like Manchester uses engines of 12,000 H.P., a line of battleship twice as much; the New Cunard steamers 48,000 H.P. each. The power wasted in the world must therefore be enormous.

If only an electrical coal engine could be found with an efficiency like that of a good voltaic cell—that is, about 90 per cent.—the bulk of the wasted power would be saved. It is for the purpose of finding the lines along which this may be done that Prof. Perry wishes to endow Lord Kelvin and Lord Rayleigh. The extravagance and folly of our present procedure, with a finite—or, rather, a limited—stock of coal is put thus:—

A Board of Trade unit obtained by human agency costs seventy pence; by a large engine in a cotton factory about one farthing. The cost of the coal alone, if all its energy were utilised is one-hundredth of a penny. To go on in the present fashion means that in 100 years our stock of coal will have gone, and our luxurious citizens will be replaced by a poverty-stricken population.

The appeal which Prof. Perry is making ought to be met with the most sympathetic consideration. And it is with the object of helping him that the comparison of costs just given is deprecated in its present form. The costs of a B.T.U., apart from engine efficiency, is generally three to four times the cost of the coal now employed. To reduce the cost of the coal will, therefore, reduce the total cost in a much smaller proportion. The point is, that if we do not economise on our present methods, the ratio of coal cost to total cost will continually increase, and finally crush the industries which depend on it. It must be remembered that much of our coal is not available in the economic sense. As time goes on, the mean depth at which coal is worked necessarily increases, and the increase will soon bring us to the point at which profit vanishes. As this vanishing point will come sooner with us than with some other nations, we have a special national interest in every method of husbanding resources.

Prof. Perry's main desire is to find a device which will avoid the low thermo-dynamic efficiency of our present steam engines. According to the second great energy law, their efficiency cannot exceed the ratio:—

$$\frac{\text{(Temp. of boiler)} - \text{(temp. of condenser)}}{\text{temp. of boiler}},$$

and this, even with our best engines, is only about 0·3.

Now this ratio could be increased by raising the temperature of the boiler, but pressure considerations generally forbid any appreciable rise in this direction. In this judgment Prof. Perry concurs, for his eye is looking for an electrical device comparable with a primary cell, but consuming coal instead of zinc. As he thinks this device will be hard to find, it is imperative not to overlook anything that seems nearer to hand. It may, therefore, be worth stating that Lord Rayleigh wrote to *Nature* on this subject in 1892. Discussing the question of superheating as described in Cotterill's work on the steam engine, he pointed out that the temperatures of the boiler could be raised without raising the pressure, by using a solution of a very soluble salt (calcium chloride, sodium acetate) instead of water. Mr. Macfarlane Gray questioned the scientific soundness of this suggestion, and a controversy ensued. Without deciding between these two authorities, we may quote the last sentence in the last letter from Lord Rayleigh.

"In conclusion, I will hazard the prediction that, if the heat engines of the distant future are at all analogous to our present steam engines, either the water (as the substance first heated) will be replaced by a fluid of less inherent volatility, or else the volatility of the water will be restrained by the addition to it of some body held in solution." (*Nat.* Vol. 45, p. 510.)

This sentence was written subsequent to a declaration by Mr. Gray that the plan had been submitted to him about 1882 by an eminent mechanical engineer, Mr. S. Geoghegan, who appeared to have patented it. Mr. Gray's opinion was against the plan, and was based on the idea that the solution would not be the working substance, and that the "latent heat" line would be the same as when the evaporation was from pure water. Thus the efficiency could not be increased. Lord Rayleigh appeared to meet these objections successfully.

It might, therefore, be worth while to investigate the possibilities in this direction, while the more formidable difficulties of Prof. Perry's quest are being overcome.

Turning now to this particular electrical scheme, all the efforts made up to the present have not merely failed—they held out no promise. Those who wish to know, will find some account of the methods hitherto tried in the book on primary batteries alluded to at the beginning of this article. It does not appear that the designers have developed their methods in view of the controlling electrical—or, rather, electrolytic—considerations.

Jablochkoff was one of the earliest workers in trying to get electrical energy direct from carbon. He used carbon and iron in fused potassium nitrate, hoping to get the energy of carbon oxidation in the external circuit. Unfortunately there is *direct* action between the fused nitre and the carbon, so that the electrical result is practically nothing.

If the work is to be done by a primary cell method, the laws of electrolysis must be kept constantly in mind. Only those chemical actions which may be described as ionic will be useful.

The other carbon plans have generally involved such collateral disadvantages that they need not be here further alluded to. Prof. Perry would undoubtedly not limit his proposal to an electrolytic method. The real line of advance may lie along some obscure electric action which has hitherto been neglected, just as the absolute zero of temperature has been approached by working on a most minute cooling due to expansion.

There are two other considerations which ought to be kept in mind. The first is the greater theoretical possibilities of the gas engine. When as many minds have been brought to bear on this as on the steam engine, it is not unlikely that the actual efficiency will *greatly* exceed that of the steam engine. The thermo-dynamic efficiency is already much higher.

The second point is this, and it is one which ought not to escape the attention of electrical engineers: a very large proportion of the coal raised in England and Scotland is used, not for power purposes, but in reducing ores, especially for producing iron. The efficiency of the methods now in use is not so high as to preclude the chance that an efficient electric machine might effect a large saving in this reduction. In considering the national aspects of the problem, this and all other possibilities must be taken into account, if the solution for the "waste" problem is to be of a perfectly general character. It does not appear whether Prof. Perry includes this in his suggestion. He does point out that Lord Kelvin had long ago indicated a large possible economy in heating buildings. But the letter to *Nature* is a trumpet call, and one that ought to provoke our leading men to both thought and action. Prof. Perry's lament is that by virtue of the classic training to which statesmen have been restricted, the strength of his plea may be overlooked by Government. Practical men are generally too busy to start such a long quest as this promises to be, but they can help on the growth of public opinion in respect to it.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London W.C., and at Liverpool, to whom all inquiries should be addressed.

7,631. "Improvements in continuous current dynamos, motors and converters." J. Atkinson. April 1st.

7,634. "Improvements in and relating to globes or shades of electric, gas and other lamps." E. Soutter and W. Soutter & Sons, Limited. April 1st.

7,642. "Improvements in, or in connection with, brushes for commutators for electric machinery." W. Kirk. April 1st.

7,651. "An aerial electric flashlight for signalling and other purposes, attachable to kites or balloons." J. E. Doughty. April 1st.

7,661. "Improvements in and relating to the electrolytic refining of lead and other lead alloys." A. G. Betts. April 1st. (Complete.)

7,665. "An improvement in dynamo-electric machines and motors." Siemens Bros. & Co., Limited, and J. G. Wilson. April 1st.

7,670. "Improvements in means for generating electricity." R. Wichand. April 1st. (Complete.)

7,684. "Improved electric arc light mechanism, applicable for rapid exposure photography." A. J. Bonnella, D. H. Bonnella & Son, Limited, E. E. R. Bryant, C. H. Bryant, and E. W. Bryant. April 1st.

7,689. "Improvements in electric signalling." J. B. Struble. April 1st. (Complete.)

7,702. "Improvements in or relating to electric ignition apparatus for internal combustion motors." H. T. Dawson and H. A. Dawson. April 2nd.

7,736 "Improvements in extinguishing electric arcs." R. H. Read. April 2nd. (Complete.)

7,773. "An improved process of oxidation by means of electric currents." A. Nodon and J. Piettre. April 2nd.

7,782. "Improvements in electrically-operated locks." O. Konitzer. April 2nd.

7,783. "Improvements in short-circuiters for high tension electric cables or wires." O. Konitzer. April 2nd.

7,792. "Improvements in electric cooking and heating apparatus." L. Lutz. April 3rd.

7,809. "An improved electric arc lamp." H. S. Scott, H. F. Tyzack, and T. J. Wright. April 3rd. (Complete.)

7,834. "Improvements in supports for incandescent electric lamps." A. Romain and J. d'Ayguesvives. April 3rd.

7,883. "Improvements in electric switches." J. A. Wright and W. F. O'Neill. April 3rd.

7,851. "Improvements relating to electrical sterilizing and preserving apparatus." H. H. Lake. (L. D. Giroux and L. E. Seddon.) April 3rd. (Complete.)

7,858. "Improvements in and relating to electric-vacuum discharge tubes." M. Krouchkoll. April 3rd. (Complete.)

7,860. "Improvements in and relating to coin-controlled machines for giving electric shocks." The New Polyphon Supply Company, Limited, and K. Schmidt. April 3rd.

7,864. "Improvements in or connected with secondary batteries." H. Korten. April 3rd.

7,893. "Improvements in conduits." C. D. Budd. April 4th. (Complete.)

7,921. "Improvements in electrolytic condensers." A. Nodon. April 4th.

7,922. "Improved means and apparatus for the distribution of electrical energy." J. Renous and A. C. L. Turpain. April 4th.

7,923. "An improvement in electrolytically coating iron with zinc." E. Goldberg. April 4th.

7,938. "Improvements in splicing electric cables." A. D. Shuter. April 4th.

7,952. "Improvements in and connected with flexible electrical connecting cords." H. Oppenheimer. (Actiengesellschaft Mix & Genest.) April 5th.

7,954. "Improvements in electric water heaters." J. W. Ewart. April 5th.

7,955. "Improvements in electrical measuring instruments." S. Evershed. April 5th.

7,957. "Improvements in electrical switches." The Electric and Ordnance Accessories Company, Limited, and R. F. Hall. April 5th.

7,958. "Improvements relating to overhead driven railway wires." J. T. Pearson. April 5th.

7,989. "Improvements in and relating to distribution boards for electrical installations." Verity's, Limited, and W. Pipkin. April 5th.

7,995. "Improvements in the production of metallic deposits by electrolysis." P. Jensen. (Dr. G. Langbein & Co.) April 5th. (Complete.)

8,014. "An improved galvanic dry cell." G. Schauli and D. Loewenstein. April 5th.

8,020. "Improvements in or connected with controlling and engaging apparatus for railway points and signals operated by electricity." A. Neelemans. April 5th. (Complete.)

8,021. "Improvements in electric distributing systems employing rotary converters." The British Thomson-Houston Company, Limited, and H. S. Meyer. April 5th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d (in stamps).

1900.

4,268. "Improvements in tools for use in the laying of tile conduits for electric conductors." H. H. Lake. Dated March 6th, 1900. A tool for aligning sections of tile conduits; consists of a helix of wire formed to fit the conduit opening, and having a central stem either in one piece with or attached to the helix. The turns of the helix act as cleaners for the joints, or brushes may be inserted in the helix. In a modified form the helix is omitted, a number of discs being securely spaced along a central stem. This stem terminates at one end in a loop to assist the drawing through. 4 claims.

4,308. "Improvements in incandescent electric lamps." R. A. Fessenden. Dated March 6th, 1900. A lamp having an incandescence rod of magnesia kaolin, or the like, conducting only after preliminary heating, is provided with means for applying to the rod streaks of graphite, manganese, peroxide, or other conductive material, when the lamp is about to be used; these convey sufficient current to heat the rod to conducting point, but burn off, or otherwise become non-conducting, when the rod becomes incandescent. The incandescence rod has strips of platinum or nickel embedded in its ends, but exposed laterally; the strips are secured on arms, insulated from a supporting shaft and connected to contacts carried by a disc on this shaft. The shaft may be rotated by hand, so that the rod rubs against blocks of the conductive material, carried by springs, streaks being thus applied connecting the strips. When the rod is turned down into the globe the contacts bear against stationary springs connected to supply conductors. The shaft and other parts are supported in a cover having a reflecting inner surface. 6 claims.

4,358. "Improvements in electric bell pushes." H. C. Swindell. Dated March 7th, 1900. To the push, which is pressed outwards by a spring resting against a diaphragm are attached two or more contacts, which pass through and have shoulders to engage with the diaphragm. The other part of the contact consists of a cup having a threaded shank, by which it is secured to the insulating disc. 5 claims.

4,365. "Improvements in translucent reflectors for incandescent electric lamps." D. Shoolbred. Dated March 7th, 1900. Incandescent lamps are provided with translucent reflectors formed to fit closely on the bulbs, and having apertures large enough to pass the ordinary caps. The lamps preferably have spherical bulbs, somewhat larger than usual, in order that the dark deposit in working may be thinner. The reflectors may be made of opal glass. 2 claims.

4,369. "Improvement in couplings for electric connections." J. J. Rawlings and W. R. Rawlings. Dated March 7th, 1900. Couplings for connecting wires in fittings such as lamp holders, ceiling roses, wall sockets, switches, cut-outs, telegraphic and telephonic apparatus, &c. A hole or holes for the wire or wires is drilled through the base parallel or inclined to the fixing screw or nut, and the bared ends of the wires clamped. 5 claims.

4,383. "Improvements in or connected with electric controlling apparatus." J. C. Licoln. Dated March 7th, 1900. Relates to controllers particularly adapted for compound-wound motors supplied from two or more groups of battery cells. The contacts are so arranged on the controller cylinder that the voltage supplied to the shunt winding is constant, though that of the series winding be changed. 5 claims.

4,387. "Improvements relating to systems of alternating current electrical distribution." C. I. Young. Dated March 7th, 1900. Relates to means for maintaining synchronism between two or more alternating-current generators supplying distributing mains in parallel. This specification is too complicated for purposes of abridgment. 4 claims.

4,457. "Improvements in electrically-controlled door locks." W. Schade. Dated March 8th, 1900. Relates to means for electrically releasing the spring latch bolt of a door lock, and so enabling the door to be opened from any desired part of the house, during the time that the ordinary locking-bolt is retracted. 1 claim.

4,461. "Improvements in or relating to electrical cables." W. J. Glover. Dated March 8th, 1900. A cable is built up with a central core of stranded wire surrounded with paper insulation. Around this are placed one or more spiral layers of flattened wire having curved edges. The spaces between the wires may be filled with insulating material or conducting wires. 4 claims.

4,500. "A new or improved self-locking elbow joint for electrical fittings." H. Hirst and J. H. Collings. Dated March 9th, 1900. A movable joint for connecting two tubes of an electrical fitting, consists of cylindrical pieces attached by sockets to the tubes, one carrying a screw on which the other is held by a nut and washer. To hold the parts at any desired angle, one part carried a spring with a pin, which engages in a groove on the other part or in recesses at the ends of the groove; or the meeting faces of the parts may have rounded teeth, to fit together in any number of positions, a mushroom spring being provided on the screw to press the parts together; or the faces may be flat, the parts being retained in any position by friction only, produced by a helical spring. Flexible conductors are passed through the tubes and joint around a grooved part of the connecting screw. 3 claims.

4,508. "Improvements in electric signalling system for electric railways." M. Gari. Dated March 9th, 1900. Relates to means for signalling and establishing telephonic communication between a signal station and a train or trains within adjacent block sections, to avoid accident in case of two or more trains occupying the same section, or for communication in other cases, as may be required. 7 claims.

4,527. "Improvements in multiple contact telephone transmitters and circuits relating thereto." C. Adams-Randall. Dated March 9th, 1900. Microphones are constructed with a number of granule cells or vibrating rods arranged in separate parallel circuits, each having its own adjustable resistance and fuse. Where there are four branches with a common return through the diaphragm, each spring is provided with a metal plug surrounded by a felt sleeve, extending forward to the diaphragm, and containing the granules. The contacts may be variously grouped, and separate batteries employed in the branch circuits. 6 claims.

4,555. "Improvements in and connected with electric distribution." J. G. Lorrain. Dated March 9th, 1900. Distributing; lighting, systems of; converting alternating and direct currents; transformers. Relates to systems of distribution in which both alternating and direct currents can be carried in the same conductors, and either can be received or taken off at any point. 10 claims.

4,570. "Improvements in overhead travelling electric cranes." W. H. Vaughan and T. Foster. Dated March 10th, 1900. Relates to automatic stopping apparatus for overhead electric cranes. On the axle of the crane barrel a single toothed pinion is mounted to drive a wheel, fitted with a projecting pin and roller, which, in the event of overwinding, strikes and operates the cut-out lever. 2 claims.

4,607. "Improvements in electrical gas lighters." H. Arnswaldt. Dated March 10th, 1900. In electric torches for igniting gas, the incandescing igniting wire so attached to the battery or source of electricity that the distance between the wire and the battery may be varied. This variation is effected by inserting in the sockets rods of different lengths, around which rods the flexible lead containing the wires is coiled, the circuit being completed by depressing a stud until a spring makes contact with a terminal. The igniting wire and its projecting tube may, however, be adjustably mounted upon a supporting rod by a spring clip or the like, and the circuit may be completed by a push-button placed elsewhere than on the source of electricity. 4 claims.

4,672. "Improvements in electrical terminals." W. Walker. Dated March 12th, 1900. A terminal is made with a tubular part slit longitudinally, tapered at the end, and screw-threaded externally to receive a screw tap, by which the tapered portion can be compressed on a wire placed in it. In a modification, a slit and tapered part is made separately from the tubular body which is screw-threaded externally and is contracted to form an internal shoulder to support the slit part when the screw cap is applied. The body may be provided with a shoulder and nut to secure it in the base of a switch. Two or more terminals may be provided on one body, for connecting two or more wires together. The body of a modified terminal may contain a sliding plunger and spring, for use in an incandescent lampholder. 2 claims.

4,680. "Improvements in electrical accumulators." A. Muller. Dated March 12th, 1900. A compound plate or electrode is made by pressing a number of grid-shaped plates containing the active material into a metal frame, so that metallic contact is established between the contiguous surfaces of the plate and frame. For this purpose the area of the combined plates is somewhat larger than the opening in the frame. 1 claim.

4,685. "Improvements in quantity meters." A. Wright and Reason Manufacturing Company. Dated March 12th, 1900. Quantity meters for alternating currents. An electrolytic meter of any kind such as a mercury voltmeter, is connected in series with an electrolytic cell containing an aluminium cathode in a solution of sodium-alum, or other electrolyte yielding oxygen, with a lead, carbon, platinum, or other like anode to rectify the current. The cell circuit may be shunted by a fixed resistance, and provided with means for producting a balancing electromotive force, described in Specifications No. 23,315 and 23,316, A.D. 1899. 3 claims.

4,706. "Improvements in electric switches." J. Lightfoot. Dated March 13th, 1900. Switches particularly adapted for incandescent lampholders. On the base are fitted or formed insulating-walls to enclose the terminals. A contact lever bridges two of the terminals and is fitted with a spring to give a quick break. A casing is provided to enclose the movement, and is slotted to allow movement of the handle. 3 claims.

4,709. "Improvements in electric cable joint boxes." G. H. Nisbett. Dated March 13th, 1900. Sheathed cables are led into two part junction boxes, the parts of which are secured together by bolts, &c. Three internal chambers are formed, the centre one being for the coupling, and the end ones being filled with elastic material holding the sheathed portion of the cable in position. The sheathing is electrically connected to the box by a soldered copper strap. The openings in the end chambers are closed by glands. 4 claims.

4,719. "Improvements in electric motors." J. Marr and W. C. Laidler. Dated March 18th, 1900. Relates to electric motors for use in cases where the load varies (*e.g.*, in connection with winches, motor road vehicles, lifting, lowering, winding and hauling apparatus, cranes, and the like), the object being to prevent damage to the motor and its connections in case of the effort of the motor being overcome by the load. 5 claims.

4,784. "Improved magnet winding for continuous current machines and converters for effecting simultaneously a sparkless commutation and a pressure regulation." M. Deri. Dated March 13th, 1900. In a continuous current dynamo or converter, the field magnet is provided with a special compensating winding carrying the main current, the said winding producing a field of variable strength and definite position, which, in combination with the main field, gives rise to a resultant field, the strength and position of which vary with the armature current in such a manner as to ensure a sparkless commutation and an automatic pressure regulation.

4,785. "An alternating current motor." M. Deri. Dated March 13th, 1900. Motors, alternating current: A motor of the type described in Specification No. 13,399, A.D. 1898, is constructed in such a manner that it may be operated entirely by alternating currents. The field magnet is provided, as before, with two windings producing different numbers of poles, but the said windings are both connected in series with the source of alternating currents, as also are the commutator brushes or sets of brushes. The armature coils form a closed circuit producing poles corresponding in number to one set of field poles, and they are also connected to the commutator so as to produce poles corresponding in number to the other set of field poles. When starting the motor, one winding may be short-circuited. When it has attained its normal speed, the other winding and the brushes may be short circuited. 1 claim.

4,803. "Improvements in electric incandescent lamps." R. A. Fessender. Dated March 13th, 1900. An incandescence rod conducting after preliminary heating, is made of thoria, magnesia, kaolin, or like material, with ends rendered gradually more conductive by admixture of magnesic chloride, magnesia (with thoria), graphite, or other suitable material. Terminals, which may be of nickel, an alloy of nickel with iron or copper, or graphite, are embedded in the ends, but exposed laterally. Each terminal may be a split ring bent helically or a flat strip, or a cylindrical end block with a part projecting into the body of the rod. The ends may be recessed to receive supporting and connecting pins. Means are provided for rubbing the rod with graphite or other material to render it conductive, and thus effect the preliminary heating when current is supplied. 13 claims.

5,032. "Improvements in electrical cut-out devices." A. Malignani. Dated March 16th, 1900. Cut-outs for preventing subscribers from receiving a current in excess of the amount contracted for, and for like purposes. 1 claim.